NATURE

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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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AMERICAN GEOLOGICAL SURVEYS *

THE volumes which record the progress of the United States Geological Survey of the Territories since its commencement in 1867 contain much information of great value to geologists, as well as to those who watch with intelligent interest the advance of the wave of human civilisation into the far West. Each of them is full of fresh illustrations of the principles of geology, such as the dependence of scenery upon rocky structure, the order of succession of formations, the plication of mountain-chains, the phenomena of volcanic action, the functions of rivers and glaciers as geological agents—illustrations which have already to some extent found their way into general text-books and are no doubt destined ere long to be made in that way familiar even to tyros in the science all over the world. In each of them too we have such information as could be gathered as to the agricultural value of the countries, the practicable routes for roads and railways, the mineral resources to be looked for, the facilities for general commerce—information which will probably serve as the basis for the future development of the regions into settled States.

During the years 1871 and 1872 Dr. Hayden's parties were at work about the sources of the Missouri and Yellowstone Rivers. They had gradually pushed on into that wild region, stimulated by the variety and interest of its scenery and geology, but they had got far from any civilised base-line, including railroads and other conveniences of transport and subsistence. Beyond them lay the lands of the Indians, who manifested no disposition to treat the peaceful work of the Survey in another light than as some insidious part of the designs of the grasping central power at Washington. It seemed desirable therefore in the meantime to discontinue the further prosecution of the Survey in the north-west until by the establishment of railroad communication it could be resumed with much less labour and cost. This delay, however, will probably not be of long continuance, when we consider with what marvellous rapidity the tide of American energy is travelling towards the Pacific.

The region recommended by Dr. Hayden and approved of by the Government as the scene to which the operations of the Survey should be transferred was that portion of the Rocky Mountain range which runs through Colorado and New Mexico—a region as yet unsurveyed and likely in a few years to be rapidly developed by some of the most important railroads of the West. The survey of the fortieth parallel by Mr. Clarence King, to which allusion has been already made, and of which some account will be given in a subsequent paper, had done good service in making known the physical features and geology of a belt of country stretching across the northern limits of the tract which Dr. Hayden now proposed to examine. That survey would form the starting-point of the new explorations which it was arranged should sweep westward across the watershed of the continent to the left bank of the Green and Colorado Rivers, eastward across the sources and higher course of the Platte, Arkansas, and other tributaries of the Mississippi, and southwards to the boundary-line between the United States and Mexico.

The first instalment of results from this transference of area has appeared in the Annual Report of the Geological Survey of the Territories for 1873—a thick volume of 718 pages, with numerous and excellent sections, maps, and views. This Report is divided into four parts, devoted respectively to—I. Geology, Mineralogy, and Mining Industry; II. Palæontology; III. Zoology; IV. Geography and Topography. An appendix contains papers on some mineral fields, while detailed descriptions of a large number of new species of fossil plants and animals are given in Part II. Taking the general supervision of the whole operations of the Survey, Dr. Hayden furnishes some chapters in reference to the geological features of part of the eastern slope of the Rocky Mountains, and introductory to those of the officers placed by him in charge of the three subdivisions into which, as already remarked, the work of the year was arranged. It appears that the first division, under the charge of Mr. A. R. Marvine, surveyed, topo-

* See vol. xii. p. 267.

graphically and geologically, an area of 5,600 square miles during the period between the end of May and the latter part of October; the third division, under Dr. F. M. Endlich, accomplished the survey of nearly 7,600 square miles, "particular attention being paid to the agricultural and mineralogical resources of the country traversed." Allowing 130 full working days for the period during which these two parties were at work, we find that on an average 100 square miles were surveyed topographically and geologically each day, and that this was performed by some seven or eight observers! And if it be further noted that only half of that number were geologists, and that in the case of the San Luis, or third division, the geological work appears to have been done by one man, we shall form some notion of the rate at which scientific surveys advance in the far West. We have not the same precise statements of the area actually surveyed by the second or South Park division, under Dr. A. C. Peale; but it seems to have been on the same extensive scale.

Now by those who take interest in the progress of topographical and geological surveying some explanation will naturally be required as to the almost incredibly large area examined in one season by Dr. Hayden's corps. Compared with his rate of progress, our Ordnance and Geological Surveys creep on at a snail's pace. His geologists, for instance, get over in a single day an amount of ground which the most hard-working and experienced members of the Geological Survey of Great Britain could hardly accomplish in a year's campaign. Evidently the two kinds of work cannot properly be compared with each other. That of the British Surveys is minutely detailed, and meant to be, for the time, exhaustive. The American Survey of the Territories, on the other hand, cannot be regarded as, and does not pretend to be, more than a rapid but intelligent reconnaissance, wherein the positions of the leading landmarks are correctly determined, and those of the intermediate features are fixed as nearly as may be; while, acting in concert with the topographer, and availing himself of the same points of observation, the geologist ascertains the nature and order of the rocks in a few traverses from which he infers what must be the structure of the surrounding districts. It is no disparagement to this work to say that it must in the end be superseded by more accurate and detailed surveys. It is in the meanwhile doing a notable service by pioneering in vast and unknown or little known regions, and giving the world a first outline of the main features of their geography and geology. In the territory of Central Colorado investigated in 1873, the geologists had the advantage of comparatively simple structure to deal with. So clearly does the skeleton of the continent protrude in that region through the surface, that from each main hill-top it was not difficult to follow for many miles on successive ridges and spurs the crags and hollows marking the lines of outcrop of particular strata. The extent to which this peculiarity and simplicity of geological physiography has been useful, may be inferred from the numerous diagram-sections of the belt of country surveyed, showing the relation of the surface-contour to the arrangement of the underlying rocks.

Space cannot be given here for a detailed account of this Report, but reference may be made to some of its features which have a general interest. Mountain-structure, especially in relation to the plications of the crust of the earth, receives much notice from the various members of the Survey. They have followed the gradual swelling of the flat formations of the plains, first into gentle ridges or "hog backs," then into more marked and crested ranges, until they have traced them in vertical or even inverted masses reposing against the central core of granite. Crossing this latter they have caught up again the same formations on the other side, and followed them in like order and position from the disrupted and highly-inclined central mass down to their gradual subsidence into the flat plains. The rocks next to the granite are metamorphosed, and, what must strike European geologists as curious, have huge intercalated sheets and dykes or veins of trachyte associated with them. The elevation of the mountain ranges has upraised cretaceous rocks, and even some parts of later geological formations.

The length of time, however, which has passed since the upheaval of the Rocky Mountains and their subsidiary spurs has allowed a vast amount of work to be done upon their slopes and crests by the weather, rain, torrents, frost, snow, and glaciers. It would seem hardly possible indeed to find a region where it would be more easy to appraise exactly the amount of waste from a given area due to this cause. The geological structure of the anticlinal and synclinal folds is so simple, the rocks are so well exposed, and the limits of sub-aërial erosion seem so sharply marked off from those of subterranean movement, that the flanks of the Rocky Mountains might be selected as a typical region for the study of this branch of physiographical geology. Sometimes the corries or cirques ("gulches" is their American name) have been cut back so as to leave a steep hardly-traversible crest between them, while now and then a valley has been cut completely across the watershed, so as to draw its first waters from the other side. In some places the rocks have been so weathered as to stand up in extraordinary pillars and capped statuesque masses like those for which Saxon Switzerland has been so long famous.

The former presence of extensive glaciers descending from the mountains of Colorado has been proved by the evidence of huge moraine mounds, admirable ice-worn domes of granite, and scattered glacier-lakes. It would seem, indeed, that no very great diminution of temperature might suffice to restore glaciers to these valleys. Dr. Hayden describes vast masses of snow and ice, which, melting in summer on the steep slopes and saturating the rocks and soil, slide down like glaciers and cumber the declivities and valleys with piles of rubbish.

The now well-known geysers of the Yellowstone region have made known the extent and comparative recentness of volcanic action in that region. We learn some further facts of interest on this subject from the present report. Dykes and streams of basalt have been found in proximity to their parent cones. In some cases the lava beds form the cappings of isolated hills, or project as terraced bars from the sides of the slopes. In other instances they occur in the bottoms of the valleys, and even appear to have sometimes crossed the present river-courses and formed lakes. Recent, therefore, though these lava-eruptions must be, they were evidently continued during a period of time long enough for deep and wide valleys to be cut

out of the older flows, while *coulées* were poured down the excavated hollows. In these respects the history of this late North American volcanic action recalls the succession of events so long ago and so admirably described by Mr. Poulett Scrope as traceable among the volcanic masses of Central France.

The mines now in operation, as well as indications of probable positions for new ones, are carefully noted in the Report. The geologists, indeed, have constantly had before them the consciousness that the future development of these territories would not be helped so much by their making out all geological details at present as by their ascertaining what practicable places could be found for the establishment of mining industry. At the same time, they deserve great credit for keeping the thoroughly scientific character of their duty so conspicuous in their reports; for undoubtedly the only way to make an exploration which shall be of real value as a guide in mining operations is to do it in the strictest sense geologically. With the area and relations of the different rock-formations mapped out for him, the mining prospector may save much time and money by learning what tracts to avoid as well as which to explore.

Each of the geologists in command of a division under Dr. Hayden furnishes a report, which appears in the present volume. These are remarkably well done, that of Mr. Marvine being specially interesting from the variety of phenomena with which he had to deal and the clearness with which he tells his story. Besides the geological reports, Prof. Lesquereux supplies one of great value on the Lignitic formation and its fossil flora, in which he enters anew into the vexed question of the true age of that formation. As the result of his long study of its large and well-marked flora, he concludes that the formation is of Tertiary date, a conclusion which agrees also with that to which Dr. Hayden has been led. A large list of new species of fossil plants from the Lignitic strata is described by him in his report. Under the head of Zoology are gathered a number of communications on insects, crustacea, mollusca, and other invertebrata, collected or observed during the progress of the Survey. The part devoted to Geography and Topography contains the reports of the geographer and his colleagues on the system of triangulation employed, the heights of various places, the practicable routes, and other matters. The book is well printed and well illustrated. It deserves the heartiest commendations both for the Government which supports such good work and for the men by whom it is practically done. ARCH. GEIKIE

ALIX ON THE LOCOMOTION OF BIRDS

Essai sur l'Appareil Locomoteur des Oiseaux. By Edmond Alix, M.D. (Paris: G. Masson.)

THIS considerable volume, the first independent work of any pretensions on the osteology and myology of birds, is a valuable addition both to zoological and to ornithological literature. As far as the latter is concerned it would have been more distinctly useful if the author had been better acquainted practically with birds' skins, as well as with the binomial nomenclature and the importance of specific distinctions. If he had, such a sentence as the following would have been modified in a manner which would have made it of greater value to future investigators, at the same time that the precision would have added weight to the points brought forward. We are told with reference to the accessory femoro-caudal muscle that "this fasciculus, represented in the Cormorant by an aponeurotic band, is found uncomplicated in the Grebe, Flamingo, Heron, Bustard, and Secretary Bird," in which remark the fact that what are there termed Grebe, Bustard, &c., are general terms, seems to be entirely ignored; as is therefore the possibility of there being structural differences among the members of the included groups. It may even be mentioned that respecting the very point referred to in the above quotation, the statement therein made does not generally apply, being correct as far as the Little Grebe (*Podiceps minor*) and the Common Heron (*Ardea cinerea*) are concerned, but being inaccurate when said of the Eared Grebe (*Podiceps cristatus*) and the Giant Heron (*Ardea goliath*). Most works on the anatomy of birds suffer from the same imperfection; the importance of specific and even generic distinctions being generally disregarded, by all but pure ornithologists.

The work is divided into three sections—the three in which the consideration of the locomotive apparatus of birds most naturally falls; namely, the consideration of birds firstly as vertebrated animals (zoologically); secondly, as a special organised type (anatomically); and thirdly, as flying animals (physiologically). An excellent *résumé* of previous investigations on the several subjects prefaces each section, in which due credit is on nearly all occasions given to foreign workers.

Under the first heading, following the teaching of De Blainville and Gratiolet, Dr. Alix describes the typical skull on the hypothesis of its vertebral origin; of the fourth or nasal vertebra, considering the perpendicular plate of the ethmoidal as the centrum, the lateral masses of that bone as the laminæ, and the nasals as the spinous element.

In the treatment of the osteology of birds, most of the important subjects which have of late attracted most considerable attention are fully discussed. We are rather surprised to find no reference to the point so forcibly put forward by Prof. Parker, and laid stress on by Prof. Huxley, with regard to the anchylosis of the palatine bones with the vomer in the Tinamous. The vomer as a separate bone is also rather neglected. As to the light thrown by a study of the skull on the classification of birds, we read that "the examination of the head of birds confirms the major divisions established originally from a consideration of the beak and the feet. It proves that Raptores, Passeres, Gallinæ, &c., exist in reality: but it also renders it evident that there are divisions beyond these not capable of being included among these primary forms. For instance, the Parrots form a well-marked group of themselves . . . the Raptores Nocturnæ are clearly distinct from the Raptores Diurnæ, the Pigeons can in no way be confounded either with the Passeres or with the Fowls." As to the sternum, "the results arrived at by De Blainville and confirmed by subsequent authors (are said to) prove that Cuvier has narrowed the question too much in affirming that the indications afforded by the sternum cannot serve for more than generic distinctions. But it must be admitted that, with the exception of the cha-

racters indicated by the presence or absence of the carina, it is almost impossible to recognise in the sternum any of those distinguishing features which may be stated in a single word, or may be incorporated as a definition in any tabular arrangement. The sternums of most birds, even those which are most peculiar, must be considered in their entirety, and a complete description is necessary for their differentiation." We would feel disposed to go even further than this, and to say that in the sternum there are characters from which, with a little extraneous assistance, more considerable generalisations may be arrived at. It is true that in the passerine *Pteroptochus* the posterior margin is doubly notched on either side, but in how different a manner from that in the piciform birds and owls! What more than the sternum proves the closeness of the relationship between the Toucans, Woodpeckers, and Capitoes, also between the Swifts and the Humming Birds, as well as the small kinship between the gallinaceous birds and the Sand Grouse? On the other hand, the sternum does not aid us much in the determination of more distant relationships, such as those of families one to the other. From it alone we should not feel justified in placing the Tinamous near the Apteryx, nor the Stormy Petrels near the Fulmars.

In the *Bulletin de la Société Philomathique* and in the *Journal de Zoologie* Dr. Alix has published his dissections of the Rhea and of a Tinamou (*Nothura major*). His myological investigations are based on the descriptions given by Vic d'Azyr and Meckel. Following the latter of these, he mentions that in the Cormorant the ambiens muscle (*accessoire iliaque du fléchisseur perforé*) is absent, which is decidedly not the case in the common species (*Phalacrocorax carbo*). With reference to this bird, the accessory femoro-caudal is said to be represented by an aponeurotic band, which we have failed to detect; and the same remark applies to the muscle itself in the Heron (*Ardea cinerea*), in which it is also said to be developed; from which we may infer that the author has evidently not clearly recognised the characters which distinguish this fleshy fasciculus from the obturator externus (*carré*); and that such is the case is further proved by his statement that the latter named muscle is enormous in the ostrich, in which it is in reality very small, being almost hidden by the former.

The flexor tendons of the toes are specially dwelt on. The flexor perforatus digitorum is shown to present peculiarities sufficiently important to deserve special names. This muscle in birds is not a single one, but is formed of a superficial and a deep group; the latter having two separate origins, an internal and an external, of which the relative proportionate bulks vary. Those birds in which the outer head is the larger are termed *ectomyens;* those with a larger internal head, *entomyens;* and those with equal heads, *homœomyens.* "The palimpeds, the longirostral and pressirostral Waders, the Flamingoes, the Storks, the Tinamous, the struthious birds and the Parrots, are entomyen; the Herons, the Rails, the gallinæ, Pigeons and passeres, are homœomyen; whilst the diurnal and nocturnal birds of prey are ectomyen." The deep flexors are said not to offer such remarkable differences as those just referred to, but as none of their most striking peculiarities are mentioned, we presume that the author is unacquainted with them. The long flexor tendon to the hind toe, we are told, is absent in the swan; it may be so in *Cygnus olor*, such is certainly not the case in *C. nigricollis.*

The last section of the work is almost entirely devoted to the flight of birds, this subject being viewed from a theoretical standpoint only. It is demonstrated in a fairly conclusive manner that the assumption of Borelli, in which the wing is considered to strike directly downwards and to turn backwards simply on account of the yieldingness of its posterior margin, is insufficient to explain the different movements observed; at the same time that it is opposed to the results arrived at from a study of the shape of the articular surfaces of the shoulder, and the arrangement of the fibres of the muscles acting on that joint. This, we think, is the tendency of modern investigation, notwithstanding the support, by M. Marey, of the opposite view. The results of the elaborate investigations of this latter able physiologist are as easily explained upon the one assumption as the other, perhaps better on the anti-Borellian theory, which no doubt is not required to account for the movements of the wings in the much less intricate problem of insect flight.

The following are Dr. Alix's propositions on this subject:—"*First.* The wing in the down-stroke begins by moving forward to attain its basis of support; after which it strikes briskly from above downwards, and at the same time from before backwards, as a result of which the bird is projected forwards. *Second.* At the moment at which the wing commences to descend, its lower surface looks forwards; but as it descends, this surface gradually turns to look directly downwards, and ultimately more and more backwards. *Third.* During the ascent of the wing, it moves upward and forward, its inferior surface at the same time looking forward." The nearly complete agreement of these observations with the results of M. Marey's previously published experiments is worthy of note, considering the differences in the starting-points of the two authors. The question of avian locomotion, as it now stands, is therefore not so much as to what are the positions of the wing during the different parts of the stroke, but as to whether the variations in the direction of its plane depend for their origin on the movements imparted to the humerus by the muscles acting on the shoulder, or on the influence of the resisting air upon a vertically moving plane which is more yielding behind than in front. This question requires further elucidation, though, as we have just remarked, we think, with Dr. Alix, that the balance of evidence is considerably in favour of the former view.

In conclusion, we strongly recommend this complete and able exposition of the locomotor apparatus of birds to all students both of physiology as well as of zoology.

"THE ABODE OF SNOW"

The Abode of Snow. Observations on a Journey from Chinese Tibet to the Indian Caucasus, through the upper valleys of the Himalayas. By Andrew Wilson. (Edinburgh and London: W. Blackwood and Co., 1875.)

LAST week we noticed Mr. Drew's almost exhaustive work on Jummoo and Kashmir; Mr. Wilson's work is to a large extent concerned with the same region, as

the greater part of the journey recorded was through Kashmirian territory. But the two works differ in many respects in design and plan. Mr. Drew has brought together so full and trustworthy a mass of information of all kinds about Kashmir as must render his work the great authority on the subject for a long time to come; his style is perfectly plain and unadorned; nearly every sentence is a positive statement of fact; he does not spend many words in admiration of the unparalleled scenery in the midst of which he lived for ten years, and he is never tempted into rapture. The attraction of Mr. Drew's work, and it is distinctly attractive, lies in the high interest and value and frequent novelty of the information contained in it. Mr. Wilson's aim, on the other hand, is to enable the reader to share, as far as words can go, the sensations which he himself felt in journeying for weeks in the midst of scenery whose grandeur cannot be adequately expressed, to present an impressive panoramic view of the "peaks, passes, and glaciers," and the fearful ravines of the highest mountains in the world, and to picture the scanty life which lurks in their lofty valleys or clings to their steep and rugged sides. His work is written, he tells us, "for those who have never seen and may never see the Himalaya. I have sought," he says, "to enable such readers in some degree to realise what these great mountains are, what scenes of beauty and grandeur they present, what is the character of the simple people who dwell among them, and what are the incidents the traveller meets with, his means of conveyance, and his mode of life?" Mr. Wilson has accomplished this task as successfully as it is possible to do it by means of language. Without apparent effort or artifice the current of his narrative flows on with delightful sweep; his style is vigorous, clear, and really eloquent, never bombastic or stilted, and with an under-current of genuine humour. He follows the only scientific method of reproducing in his readers the impressions made upon himself by the Himalayan scenery—by representing in simple but striking language the features which stirred his admiration and awe, never indulging in those futile and vague expressions of ecstasy which are a mark of the feeble observer, unscientific thinker, and unskilled writer. At the same time Mr. Wilson manages to convey a very considerable amount of information, and whoever reads his work with care will have realised to some extent the character of the region which it attempts to describe.

Mr. Wilson's main object in undertaking his toilsome tour among the Western Himalayas was to invigorate a constitution prostrated by the trying climate of India. His original intention was simply to visit Masuri and Simla, "but the first glimpse of the Jumnotri and Gangotri peaks excited longings which there was no need to restrain," and he plunged into the heart of the Himalayas. His journey lasted from June to November 1873. His real starting-point was Simla, though he gives valuable information as to other routes, and makes many shrewd comments on the men and manners of the various places through which he passed before reaching this point, on society and politics, and on certain burning questions connected with our Indian Empire. From Simla he proceeded up the stifling valley of the Sutlej to Shipki, where he made a vain attempt to get into Chinese Tibet; he was worsted by the women of the place. Hence he proceeded in a generally north-west direction by the Lee River, through the Schinkal pass, past Padam in Zanskar, to Dras, visiting Sirinagar and the Vale of Kashmir, and on westwards by the Jhelam River to the Khyber Pass. This is easily told, but the difficulties Mr. Wilson had to encounter are almost incredible, especially when it is considered that he was an invalid in search of health; for a month he was laid up at Pu, not far north from Simla, by an attack which nearly proved fatal. He camped out nearly all the time, had frequent difficulty in procuring provisions for himself and his small retinue, had often to scramble along paths not much broader than a mantel-shelf, overhanging ravines many thousands of feet deep, had to risk being lost in glaciers and frozen to death on passes upwards of 16,000 feet high. He bore it all with infinite good humour, and reached the Khyber Pass, we have no doubt, a stronger and a wiser, and quite as cheerful a man as when he started from Simla.

Mr. Wilson's work, as we have hinted, is something more than a fascinating tale of travel. While he gave himself up unrestrainedly to the scenic influences in the midst of which he sojourned for five months, he was quite alive to all the principal features of interest which presented themselves. There are frequent references to the animal and vegetable life of the region, to its grand physical and geological phenomena, and especially to the characteristics of the interesting people who inhabit the not infrequent villages on the route. He has added something to our knowledge of the glaciers of this part of the Himalayas. Mr. Wilson had several opportunities of observing closely the life of the people, and the information he gives will be found of value even by those who are familiar with the literature of the subject. He speaks, as might be expected, at considerable length on the polyandry and Lamaism which prevail over a considerable part of his route, and his remarks are characterised by great moderation and good sense. We wish we had space to quote the exquisite picture of domestic life which Mr. Wilson witnessed while snowed up at the village of Phe, in Zanskar. He seriously suggests the possibility of the Turanian Zanskaris being "congeners of the Celtic race."

He tells us a good deal, of course, about the Vale of Kashmir, and, like Mr. Drew and other geologists, concludes that it was at one time, and that not very remote, a great lake; he enters into some interesting speculations on the prehistoric inhabitants and condition of Kashmir. When near the end of his journey he made a bold raid across the Afghan frontier, and has a chapter on Afghan ethnology and the Afghan character.

In a chapter written under the influences of a moonlight midnight among the Himalayas—and how awe-inspiring and "other-worldly" such influences must be, one can easily imagine—Mr. Wilson indulges in some curious speculations on the struggle for life in the organic, and especially in the animal world, as contrasted with the inorganic. We think he has struck quite a wrong key here, and has not an adequate grasp of the facts of the case; but even if we had space we could not enter into his argument, as it is mixed up with certain subjects that are beyond the sphere of NATURE.

"The Abode of Snow" will, we believe, take its place as one among the few of our really classic works of travel.

OUR BOOK SHELF

Further Researches in Mathematical Science, embracing the Appendix of "The Two Discoveries." By the author of "The Two Discoveries." (Clement Pine, Taunton Road, Bridgwater, 1875.)

OUR readers may ask, who is the author of "The Two Discoveries," and what are the Discoveries? An advertisement informs us that Mr. Clement Pine himself is the former, and that the subjects of "The Two Discoveries" are "The Mathematical Discovery, the Spiritual Telegraph, Astronomy, Cause of the Changes of the Seasons, Botany, Capillary Attraction, or the Principle of Growth; Religion, Progression, Scenery in the Spirit Realm, &c., and a variety of other topics." A suggestive list! We shall extract a *morceau* here and there which will indicate the nature of the present pamphlet. There are "important discoveries in a science in which very slight advances have been made since its foundation was laid by Euclid." We commend this to the "Improvement of Geometrical Teaching Association." To his scholastic ignorance and to his loss of sight, Mr. Pine attributes the fact of his attention having been turned to these subjects and of his having hit upon shorter, simpler, and more effectual modes of obtaining certain results.

After a personal narrative, he tells us he bought a guitar. "The guitar having only six strings to perform a melody which may require sixteen whole tones, besides semi-tones, to be effected by shortening the strings by fingering, I had now a fair field open for my calculations. So I conceived a musical instrument of sixteen strings similar to the guitar, which would require no shortening of the strings by fingering, but which could be played straight ahead, each string representing a different note, like the harp. Now, all my stock-in-trade in mathematical science was a knowledge of the properties of the right-angled triangle, which, connected with the rule of proportion known as the Rule of Three in arithmetic, seemed like a magic key to unlock the mysteries connected with geometry and trigonometry." He then dwells on the properties of the right-angled triangle. The especial property is the discovery imputed to Pythagoras. This he expects is of "greater value than any other axiom in mathematics." He simplifies "this simple axiom, and if you want it any plainer, the only way is to set your own brains to work." With his Minstrel (the musical instrument) he has plenty of amusement. "I would be so absorbed in calculating and committing the numbers arrived at to memory as to be quite unconscious I had lost my sight. The outer world was invisible, but the inner world of the spirit was transparent." He then comes to his main point, viz., the true mode of obtaining the distances of remote objects by observation. "My mind must have been occupied on this theorem for five or six years, and it was not until a year after the recovery of the sight of one eye that I discovered the principle. At length it came to my mind like a flash of lightning, first to find the correspondence of the circle to the square; and then to obtain the distance by the proportion of the paralax (*sic*) to the length of the square for a divisor, and the length of the base line measured or obtained as the multiplier. . . . The principle itself is perfect, and the approximation to perfection in its application depends altogether on the comparative perfection of the instrument used and of the observations made."

There are two diagrams and long descriptions. We have preferred to let our author speak for himself, and so to show that if he is not affected with the *morbus cyclometricus*, the diagnosis points to a disease nearly allied to it. Further, we have hardly dared to discuss the pamphlet in other fashion on account of the paragraphs on p. 12, prefaced with the remark, "But what is to come will startle you." "I have been receiving from my honoured father in the Spirit Realm, John Pine, senior, some two dozen essays on philosophical subjects. He was giving his views on religion in very forcible language, and thinking I was becoming too excited, he made a sudden change to trigonometry, and then referred to my diagrams, and the importance of my discovery in mathematics; and that it was my duty to lay it before the world. I said it seemed to me very complete for terrestrial observations, but I was not aware that it would apply to astronomy. He remarked that it was equally applicable to astronomical as terrestrial observations; and he insisted that I should continue my researches on the subject. I have taken his advice, and have continued my mental researches; and shall now present them for public scrutiny." His father further states: "Two years ago, or more, when you used to be showing them to ——, I was with you all the time when you were studying on the subject, and am better acquainted with the diagrams than you are yourself." With the announcement of this "Imprimatur" we close our notice of this singular farrago.

Notes on Forestry. By C. F. Amery, Deputy Conservator, N.W. Provinces, India. Pp. 119. (London: Trübner and Co.)

THIS is a little book written by a forest officer for the benefit of those Englishmen who, having been trained in the schools of forestry in France and Germany, require a convenient handbook written in their mother tongue to guide them in their future operations in forest work. Bulky books in the languages of the two countries just alluded to already exist, but these, as the author says, deal so largely in details that the student has frequently to wade through a great mass of matter before he can get a clear view of the individual facts he is specially in search of, or of the broad general principles which govern forest administration. Considering the number of educated and intelligent men now employed in the Forest Department of India, we might suppose that some would be tempted to record their experience for the benefit of those who may be working in the same cause. Dr. Brandis's "Forest Flora" is the first trustworthy work devoted to the scientific and economic aspects of the Indian forests, but besides a knowledge of the trees themselves the practical forester requires to know more than a little about the planting and thinning of trees, the transport and measurement of timber, &c., and it is upon these matters that Mr. Amery's "Notes" deal. He points out that Nature's method to foster the growth of the young seedlings is to allow the admission of sufficient light and air. The practice prevailing in Germany is to thin out the young plants at first only lightly to assist germination, then to admit more light to encourage healthy development. "The period between the first thinning and final clearing varies from ten to thirty years. On the plains of India, such is the rapid growth of some of the trees in their earlier stages as compared with the rate of growth in Europe, that it will probably not be desirable to extend the period beyond two or three years; but this difference of conditions does not affect the principle, which is the admission of as much light and no more than is necessary to the well-being of the young crop at every stage." The seedlings of some of the finest timber trees are of so delicate a nature that they have not power to struggle through any kind of undergrowth, even through rank grass: to overcome these difficulties it is recommended that in ordinary grass land the sods should be removed and inverted grass to grass, and the seeds sown on the inverted sod, which should be from five to six inches thick. The advantages of this system are, that the seedling plants are elevated a few inches above the surrounding soil, so that they have no foes to contend with in the early stages of their growth. From these remarks it will be seen that the book is entirely practical, and will, we have no doubt, be consulted by young foresters.

J. R. J.

Nebraska; its Advantages, Resources, and Drawbacks. Illustrated. By Edwin A. Curley. (London: Sampson Low and Co., 1875.)

MR. CURLEY acted as the Special Commissioner of the *Field* to the emigrant fields of N. America, and the present work appeared originally, we believe, as a series of papers in that journal. Mr. Curley has evidently done his work as Commissioner thoroughly, and the present volume is an almost exhaustive account of Nebraska from an emigrant point of view, and we would strongly recommend all intending emigrants to study it carefully. The author sets forth with perfect impartiality all the advantages and disadvantages of Nebraska as a field for emigration, with the result that for those who can command a small capital, and are able and willing to do the necessary work, there is every chance of success. Mr. Curley describes the Geography of Nebraska, and has two chapters of statistics. There is a chapter on the Climate, two chapters on the Surface Geology, and one on the Wild Fruits of Nebraska, by Prof. Aughey. In a series of chapters the author describes in considerable detail the principal districts of the State, and has chapters on Timber and Fuel, the Pastoral Capacities of the State, Co-operative Colonisation, and Land. Indeed, the work seems to contain answers to every inquiry that an emigrant is likely to make, down even to routes, steamship lines, and fares. It is illustrated with many well-executed woodcuts, lithographs, maps, and plans; and even those who have no intention of emigrating will find it pleasant and instructive reading.

A Series of Twelve Maps for Map-Drawing and Examination. By Charles Bird, B.A., F.R.A.S., Science Master in Bradford Grammar School. (London: Stanford, 1875.)

THE twelve maps are Europe, Asia, Africa, North and South America, England, Scotland, Ireland, France, Germany, India, and Australia. They are simple outlines, showing the courses of the chief rivers, the run of the mountains indicated by black lines, and the situation of the principal lakes. The maps, instead of names, are covered with a large number of figures which refer to a copious index at the end. The intention is, that after the student has become thoroughly familiar with the situations of the principal mountains, rivers, towns, and other features of a country, his knowledge should be tested by his being required to fill in, in these or similar skeleton maps, the names corresponding to the figures furnished or pointed out by the teacher. It is also intended to provide a handy method for drawing maps. We believe that if judiciously used, the method here indicated will be of good service for both purposes. The maps are well drawn, and, so far as we have tested them, accurately constructed.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Observation of Cirrus Cloud

I HAVE just received from the Meteorological Observatory at Upsal, Sweden, a number of blank forms (with instructions in English) for observations of the directions of the cirrus cloud. Copies of these forms I shall have much pleasure in supplying to anyone who may be willing to make observations of these clouds, the systematic and extensive observation of which is, as you pointed out in a recent number of NATURE, of such importance in numerous meteorological inquiries.

ALEXANDER BUCHAN, Secretary
Scottish Meteorological Society, Edinburgh, Nov. 2

Mr. Mallet's Paper on Prismatic Basalt

IN a paper published in the *Geological Magazine* for September last, and entitled "Note on Mr. R. Mallet on the Prismatic Structure of Basalt," by Mr. Scrope, that author conceives he has found a refutation of the explanation which I have given of the production of the transverse joints in prismatic basalt in my paper on the subject published in the *Philosophical Magazine* for August and September 1875, and Proc. R. S. 158, 1875. For this he appeals to the features presented by the transverse joints in a group of three prisms stated to be from the Giant's Causeway, existing in the hall of the Geological Society of London. In one of these three prisms it is stated that the convex surfaces of the two top joints point in opposite directions, so that the upper articulation "is found to be biconcave in the fashion of a double concave lens. In another of the prisms the convex surfaces of the joints point downwards, while in the third the convex surfaces point upwards."

I will assume that these three prisms occupy the same relative position with respect to each other vertically that they did when *in situ*, and that Mr. Scrope's description of the jointing is exact, which, however, is not the case; *e.g.*, the top surfaces of the three prisms are not alternately concave and convex, but all are concave, though in different degrees. The entire length of the prisms referred to is about $4\frac{1}{2}$ feet, and the group must have been taken from a mass cooled both from above and below. The phenomena presented by the joints of these prisms do not conflict with the views which I have enunciated. The prisms referred to have come from some portion of the original mass in which occurred the dividing plane between that part cooled from the top and that cooled from the bottom, as is proved by the existence in one of the columns of a joint having surfaces curved in opposite directions; such plane, in fact, passing transversely through the articulation said to be in the form of a double concave lens. Other adjacent prisms may have their joints, within a limited vertical height above or below this plane, either convex upwards or downwards, for the slightest differences in the conductivity or in the conditions and rates of cooling, will suffice either to depress or to elevate in them, by a greater or less degree, the plane already spoken of. It is also not difficult to see that several alternations in the directions of the concave and convex surfaces may occur in the neighbourhood of the meeting plane of cooling in opposite directions, where, as in the case of other divergent or opposite heat waves, more or less confusion in normal structure must occur.

I have not examined the group myself, nor should I care to appeal to such fragments either in refutation or support of any theory. Mr. Scrope's imaginary refutation appears to resolve itself into a confirmation of the exactness of my views, and is the product of his imperfect grasp of the physical conditions involved in the question which he undertakes to discuss. That Mr. Scrope has got but a very incomplete grasp of my views as to the production of the cross-joints in prismatic basalt, is evident from the inaccurate language in which he professes to describe that portion to which he refers, as may be seen by those who take interest enough in the subject to compare his note with my paper (*Philosophical Magazine* for August and September 1875), and more especially from p. 134 to p. 205.

Oct. 18 ROBT. MALLET

Plagiarism

MAY I ask you to allow me a very small portion of your space to anticipate a charge of plagiarism which might otherwise be made against my work on Cave-hunting, by the readers of the article in the *Leisure Hour*, entitled "The Early Geography of the British Islands, by Henry Walker, F.G.S., July 1874," which I now see for the first time.

In this article there is a map (p. 423) so exactly like my own that it is obvious that one is copied from the other, and it might be believed (it has been suggested) that mine was taken without acknowledgment from Mr. Walker, since his was published in July, and mine in October, 1874.

The facts are as follows:—In October 1871 I published a map in the *Popular Science Review*, and this is reproduced, with certain details left out, by Mr. Walker, without allusion to my previous publication. I reprinted my map of 1871 in "Cave-hunting."

Now, I would willingly and heartily allow any map of mine, in which the labours of others are combined with my own, to be used by others without acknowledgment; but that in consequence of this I should be open to the charge of plagiarism, as in this case, I do not feel justified in letting pass without a word as to the facts. W. BOYD DAWKINS

City of Melbourne s.s., off San Francisco, Sept. 16

The Internal Heat of the Earth

On looking over the account, contained in vol. xii. p. 545, of Prof. Mohr's interesting observations on the internal heat of the earth, I found that, according to the law which seems to prevail between the depths of 700 and 3,390 feet, there will cease to be any increase at all in the temperature exactly at the depth of one English mile, or 5,280 feet.

The reason of the discrepancy between this result and that previously given, is to be found in the last entry in your table, where only the upper part of the stratum between the depths of 3,300 and 3,500 feet, is taken, instead of the whole 200 feet, as in the other strata.

The following continuation of the table will make this evident :—

Depth.	Increase per 100 feet.
3300 to 3500 feet	0·445° R.
3500 „ 3700 „	0·395 „
3700 „ 3900 „	0·345 „
3900 „ 4100 „	0·295 „
4100 „ 4300 „	0·245 „
4300 „ 4500 „	0·195 „
4500 „ 4700 „	0·145 „
4700 „ 4900 „	0·095 „
4900 „ 5100 „	0·045 „
5100 „ 5280 „	0· „

By adding the various increments of temperature below the depth of 3,390 feet to the temperature there observed of 36·756° R., we obtain 40·81° R., or 123·82° F. as the maximum temperature.

To temperature at		
3390 feet	=	36·756° R.
Add at 3400 „		·044 „
„ 3500 „		·445 „
„ 3700 „		·790 „
„ 3900 „		·690 „
„ 4100 „		·590 „
„ 4300 „		·490 „
„ 4500 „		·390 „
„ 4700 „		·290 „
„ 4900 „		·190 „
„ 5100 „		·090 „
Between 5100 and 5280		·045 „
		40·810

There is a further remark called for by the manner of filling up the gap above 700 feet. If we compare the increment given for the stratum between 600 and 700 feet, namely 1·10, with that of the next stratum, namely, 1·097, we get a difference of only 0·003 instead of 0·05, as in all other parts of the table. It would be more in accordance with the lower part of the table if we could proceed thus :—

Depth.	Increase per 100 feet.
Above 100 feet	1·30°
100 to 300 „	1·25
300 „ 500 „	1·20
500 „ 700 „	1·15
700 „ 900 „	1·097 = 1·10 nearly.

Whether the facts observed will warrant such an extension of the table is a question into which I forbear to enter.

Bradford, Oct. 27 JOHN WILLIS

OUR ASTRONOMICAL COLUMN

40 ERIDANI.—Prof. Winnecke measured, in addition to the well-known distant companion of this star, which is affected with nearly the same large proper motion, two small stars which he calls D and E. It would be interesting to ascertain if these stars are fixed, or if they also follow the principal one in its rapid motion through space, and measures taken during the present season may be expected to decide the point.

The results obtained in 1864 are :—

A D	1864·842	Position	185°·04	Distance	75″·85
A E	„	„	312·48	„	89·45

If we adopt Mädler's proper motions for 40 Eridani, from the Dorpat Observations vol. xiv., or − 2″·188 in R.A. and − 3″·470 in declination, we find for 1875, Nov. 15, if D and E are fixed—

A D ..	Position	155°·2	...	Distance	41″·1
A E ...	„	336·9	...	„	107·3

Sir John Herschel had probably in view the physical connection of D and E with their bright neighbour when he suggested that at least a diagram of the relative situation of the small stars near it should be made.

The *comes* B which partakes of the large proper motion of A is itself a close double-star, H. 80 of Sir W. Herschel and Σ 518, and Struve first notified its probable binary nature. Dawes refers to the difficulty attending measures in 1851, but the list of epochs is decisive as to rapid orbital motion. We have for comparison—

Herschel	1783·08	Position	326°·7	Distance	4″—8″
Struve	1825·12	„	287·7	„	...
O. Struve	1850·94	„	160·2	„	3·93
Dawes	1851·06	„	160·0	„	3 ±
O. Struve	1851·50	„	160·2	„	3·85
Winnecke	1864·85	„	147·6	„	4·46

Dawes estimated the magnitudes of the components 10½ and 11, but there is a suspicion of variability of the smaller one.

PROPER MOTION OF α^2 CENTAURI.—The values given in our catalogues for the proper motion of this star in declination are not so accordant as might be expected if only the more reliable or modern observations are used. Thus the Cape General Catalogue has + 0″·83, the Melbourne General Catalogue + 0″·49.

Perhaps as reliable a figure as any that can be derived from data so far published will be obtained by comparing the declination of the Melbourne Catalogue with that given by the Astronomer Royal's reduction of the observations of the Rev. Fearon Fallows at the Royal Observatory, Cape of Good Hope, 1829-31. With Prof. Peters' elements for precession, this comparison gives + 0″·4399. If we similarly compare with Johnson's observations at St. Helena, we find + 0″·4867. Probably La Caille's declination has been used in working up the adopted Cape value, as on comparing it with the Melbourne declination for 1870, we should have for the proper motion, + 0″·723.

For proper motion in right ascension, the comparison of Fallows and Melbourne General Catalogue gives − 0·5235s., and the substitution of Johnson for Fallows alters this to − 0·5462s.

THE "ASTRONOMISCHE NACHRICHTEN."—A General Register of the contents of this publication, so indispensable to every practical astronomer, from vols. lxi. to lxxx., by Dr. C. F. W. Peters, is announced (Mauke, Leipsic).

The last number contains the Washington observations of the satellites of Uranus and Neptune during the first five months of the present year, with numerous measures of the position of the companion of Sirius in the years 1873-75 ; also, remarks by Prof. Asaph Hall on the determination of the mass of Mars from perturbations of the minor planets, in which Massalia, Echo, Beatrix, and Peitho are mentioned as the planets best adapted for this purpose. Magnifying powers of 610 and 890 were generally used for the satellite-observations, but on a few occasions one of 1,290 was employed ; the companion of Sirius was generally measured with 400, all the observations being taken with illuminated wires in a dark field.—The death of Dr. August Reslhuber, so long director of the Observatory at Kremsmünster, is announced.

A NEW PALMISTRY

DR. ALEXANDER ECKER, the well-known authority on matters prehistorical, as well as Professor of Comparative Anatomy in Freiburg, Baden, contributes to

a recent number of the periodical, of which he is a joint editor, a most suggestive paper, entitled "Some Remarks upon a Fluctuating Character in the Human Hand."* As the line of research is somewhat uncommon, and may, for aught we know, be productive of important results, the substance of Prof. Ecker's paper is here presented to English readers in an abridged form.

Henle, in his work on Anatomy, has made the observation that people have very vague ideas about objects even which are assumed to be well known; *e.g.* the query is often put, How many feet has a crab? or, How many toes has a cat?—questions which receive most varying answers even in well-informed and educated circles.

If, then, the question be put in the company of half a dozen people, which finger is the longest—the index (forefinger) or the "ring" (fourth) finger?—the query can but seldom be answered before the members in question have been looked at. It seems, further, very probable that the authors of well-known anatomical works have laid down as being the rule that which they have observed on their own hands, so that we are enabled to tell in what respect, as to digital arrangement, such and such *savant* is endowed. For instance—Weber says that the "ring" finger is only slightly shorter than the index; Carus holds that the latter digit is shorter than the ring finger; Henle is of the same opinion; while, according to Hyrtl, it is the index which comes next to the middle finger (the longest) in length; and Langer, lastly, says that the index is generally shorter than the "ring" finger, but that there are individuals in whom they are nearly of the same length.

Have these variations a morphological significance or not? For the solution of this, answers to the following questions are necessary:—

(*a*) How are the animals which come next after man, in other words, the apes, and especially the anthropomorphous apes,† off in this particular?

(*β*) What is the case with the lower races of mankind in the same particular?

(*γ*) What is the most usual digital arrangement in this respect among the European races of man? and lastly,

(*δ*) Which proportion of the two digits in question has been accepted as the most beautiful and symmetrical, and either knowingly or unknowingly adopted in art?

1. With regard to the Ape, the index is—and often considerably—shorter than the "ring" finger. The difference in length is much more considerable in the Chimpanzee than in the Gorilla; the greatest difference, that of 20 mm., having been found in the cast of a hand of a male Chimpanzee.

2. Drawings—made by placing the hand upon paper, the axis of the middle digit coinciding with a straight line at right angles to the front or hind margin of the paper, supposing the latter to be a parallelogram, and then following the outline of the fingers with a pencil—were made of twenty-five male and twenty-four female negroes, with the following result:—

(*a*) Among the males twenty-four had the "ring" finger longest, the average difference being 8 mm., while in the remaining instance both fingers were of the same length.

(*b*) Out of the females the "ring" finger was longest in fifteen, the difference varying from 2 to 14 mm.; in three the fingers were of the same length; while in six the index was the longer, the difference being from 2 to 6 mm.

Prof. Ecker has further found the "ring" finger longest in casts and in several photographs of the hands of negroes; but in the hand of a "Turco" negro the index was the longer of the two digits. In photographs of a Hottentot and of an Australian female, the "ring" finger was the longer, while in a photograph of a female Sandwich Islander the reverse was the case.

3. As for Europeans, no conclusions have as yet been arrived at; but it appears probable that there is a relatively greater length of the index finger in the female than in the male sex; and further, among the latter, in the slight and highly developed, than in the short and underset.

4. Lastly, as regards Art. In that which is left to us of the productions of the ancients, there are variations in the relative length of the two digits, though it appears that the index finger, and especially so in the female, ought to be the longest. In the Dying Gladiator the index (of the left hand supported upon the knee) is the longer; while in the Apollo "Belvedere" (right hand) there is no appreciable difference. In the Venus "Medici,"* in the Venus "pudica" of the Gallérie Chiaramonti, in Rome, as well as in the Venus by Praxiteles, in the Vatican, the index is obviously the longest. In modern art there seems to be no evidence of rule or canon; among painters, for instance, there being, it appears, no fixed tradition on this point. In Schadow's "Polyklet, oder von den Maassen des Menschen nach dem Geschlecht und Alter" (2te Aufl. Fol., Berlin, 1867) no rule is laid down. In the extended hand of a powerful man, by Albrecht Dürer, the "ring' finger is the longest.

It is not probable that a difference in the length of the fingers in question is a merely individual, so-called chance (zufällige) variation, for the reason that the whole form of the hand is in relation with this. In the variety of hand termed *elementary*, by Carus ("Ueber Grund und Bedeutung der verschiedenen Formen der Hände in verschiedenen Personen;" 4to., Stuttgart, 1846), the index is shortest; in the *motor* variety the difference is not considerable, the index being slightly the longer; in the *sensible* form the index is longer, but not much so; while in the *intellectual* (seelische) this finger is considerably the longer. The opinion just given is further supported by the fact that in the Mammalia the length of the various digits is very constant.

It may be concluded, then, that—

α. In the Apes as yet examined, the difference being least marked in the Gorilla, the index finger is the shorter.

β. In Negroes, also, the index appears to be the shorter. No sexual difference can as yet be established.

γ. In Europeans the variation is so great that at present no rule can be laid down.

δ. When a great artist has attempted to represent a beautiful and ideally perfect hand, he has never made the index strikingly shorter than the "ring" finger.

May it then not be possible,—

1. That an index relatively longer than the "ring" finger is the attribute of a higher form of beauty?†

2. That here, as in many other particulars, the female form appears to be morphologically the purest?

The longest and least mobile finger is the middle one; the shortest, and most capable of motion, is the thumb, or "pollex;" next in order in the scale of mobility come the little, "ring," and lastly the index, or forefinger.

The question which Prof. Ecker has here raised, and into which he intends to inquire further, may appear to some trivial and unworthy of serious study; but, far from this, the satisfactory solution of it will, there is but little doubt, be of the greatest interest not only to the philosophical anatomist, but also to the sculptor and painter who would fain go a little below the mere surface of his art. It is certainly a subject in which, were they yet alive, such men as Goethe and Winkelmann would take the deepest interest.

JOHN C. GALTON

* "Einige Bemerkungen über einen schwankenden Character in der Hand des Menschen." *Archiv für Anthropologie*, viii^er Bd. s. 67.

† Such as the Orang, Gorilla, Chimpanzee, and Gibbons.

* The famous Medician Venus has been said to be a copy by Cleomenes, a son of Apollodorus, of the Venus of Cnidos, by Praxiteles. *Vide* Winckelmann's "Geschichte der Kunst des Alterthums."—J. C. G.

† The hands of the writer are, unfortunately, specimens of the lower type, each index being considerably shorter than the "ring" finger in the same series. It is a curious fact that in each hand the radial artery at its termination, instead of plunging beneath the volar muscles, takes a superficial and somewhat dangerous course as far as the skin web which passes from the pollex to the index. It would be interesting to know whether these phenomena are correlative or not.

SCIENCE IN GERMANY

(*From a German Correspondent.*)

HERR NEESEN, assistant to Prof. Helmholtz, has recently published a memoir on the phenomena of attraction and repulsion by light and heat-rays, observed by Mr. Crookes. He states in it that he had already for two years observed such phenomena, which at first seemed to be a case of mechanical action of light-rays, *i.e.* of the effect of their impinging and rebounding on the surface of a mirror suspended by a cocoon-fibre. He now thinks, however, from the experiments he has made, that the effects of light and heat-rays in question are to be regarded as merely produced through air-currents arising from heating of the air in certain parts of the apparatus in which the movements of the mirror take place. Neesen first shows that in the phenomena observed such air-currents have, in fact, influence. He used for his experiments a rectangular case of sheet iron, in the upper cover of which was a peculiar arrangement for hanging a cocoon fibre. In the lower part of one of the sides of the case was a rectangular aperture closed by a plane parallel glass plate, and behind this plate was the suspended mirror. The air-currents above referred to arise not only from the fact that the air in contact with the glass plate through which the light must pass to reach the mirror, or the air in contact with the mirror, is heated. The air-particles also between glass plate and mirror are heated by conduction of the heat; and so, by their heating also, air-currents are produced which tend to turn the mirror.

In favour of Neesen's explanation are the facts (1) that the movements of the mirror always decrease when the air in which it is enclosed is rarefied; and (2) that these movements also become less if adiathermanous substances (*e.g.* a column of water) absorb the light-rays before these can reach the mirror.

The considerations which seem to be against his explanation are the following:—(1) The reversal of the movement, observed by Mr. Crookes, on a certain small air pressure being reached; (2) a fact appearing from Neesen's own experiments, viz., that according as the direction in which the light-rays fell on the mirror was varied, was the direction of rotation of the mirror changed, though the light fell on the same part of the mirror. Both these peculiarities, however, may also be explained by air-currents. First, as regards the fact observed by Neesen, it is clear that, according as the lamp is placed to one side or the other of the mirror, different parts of the glass plate in front are heated, and different parts of the air-layer between glass plate and mirror; and accordingly the currents and the rotation of the mirror must have an opposite direction. To explain the reversal of the motion on a certain low pressure being reached, Neesen calls to mind that the conductivity of air for heat, as Kundt and Warburg have shown, decreases with extraordinary rapidity on decrease of pressure (well observed with low pressures); so that with as perfect a vacuum as possible, it entirely disappears, and only radiation of heat remains. Now, as long as the heat is conducted, the air-particles conducting the heat are themselves heated. On the other hand, no such heating takes place when the heat passes only by radiation. That with such very different conditions the currents may be different is probable in a high degree. W.

MÜLLER ON BEES AND FLOWERS*

IN this communication Dr. Müller calls attention to the interesting facts presented by various groups of Hymenoptera, in which we find a series of forms presenting more and more complex life relations, accompanied by a higher and higher mental organisation. The consideration of these gradations is calculated to throw much light on the question, "How has the Honey Bee acquired its remarkable instincts?" a question which the study of that species alone would, in his opinion, do little to solve, but on which the habits and organisation of other groups throw much light. The Sawflies (*Tenthredo*) are amongst the lowest of Hymenoptera. They merely choose a plant of the species on which they have themselves lived, cut a hole in the leaf with their curious saw, and deposit therein an egg. The young larvæ thus find themselves on their food and live like ordinary caterpillars, which in general appearance they much resemble, and like which they are exposed to destruction by various enemies.

Passing on to the Gall Insects (*Cynips*), we meet with a new mode of life which is very instructive. The incision made in the plant by the Sawfly causes little abnormal growth, while in the case of the Cynipidæ, on the contrary, it gives rise to the well-known galls.

Some species, however, pierce not plants, but animals, and have thus opened out for themselves many more possibilities of existence, since there is scarcely any group of insects which is free from these attacks; neither the thick-skinned beetle, nor the active and powerful wasp, nor the woodboring larvæ of Cerambyx, nor even the aquatic larvæ of the Phryganeas.

This passage from phytophagous to carnivorous habits has not only led to the formation of many new species, but also to a greater complexity in the relations of the parents to their young, and to a higher intellectual development, which is shown especially in the arrangements made for the nourishment of the larvæ, since it certainly requires both greater energy and more intelligence to discover and attack a particular species of insect than merely to lay an egg on the plant which has served the mother herself for nourishment. The passage from the gall insects to these insect-piercing species must, in M. Müller's opinion, have been slow and gradual. The genus Synergus, which deposits its eggs in the galls of the true gall insects, constitutes, perhaps, a link between the two groups.

On the basis of this increased energy, intelligence, and adaptability, certain groups then made a still further advance by which some of the drawbacks incident to such a mode of life were avoided. For it of course frequently occurs that caterpillars and other insects in which these insect-piercing Hymenoptera have deposited their eggs, are devoured by birds or other enemies. Certain species, however, meet this danger by transporting their victims to a place of security. To effect this, however, certain conditions are necessary. The aggressor must be sufficiently large to overpower his victim, but the latter must not be killed, or it would decay and thus become unsuitable for food. Dr. Müller considers that many insect-boring species have probably endeavoured to secure their prey, but have under these circumstances found it impossible to do so. Thus, the ovipositor of the Tenthredo became the sting of the wasp, and thus those species which carried off their victim to a place of concealment would abandon the habit of laying their eggs inside the victim. Dr. Müller expresses the opinion that the various proceedings by which the solitary wasps thus protect their young against contingencies to which the insect-piercing species are liable, must have at first been arrived at with a consciousness of the object to be effected, but that they have gradually become instinctive, and are now unconsciously inherited from generation to generation. Still it is, he observes, impossible to watch a wasp at work without feeling that, with these inherited customs, or so-called instinct, much individual effort also comes into play. Dr. Müller proposes to discuss this interesting part of the subject in detail in a future communication. J. L.

* "Die Bedeutung der Honigbiene für unsere Blumen," in the *Bienen Zeitung* for July 15.

*FAYE ON THE LAWS OF STORMS**

Mechanical Identity of Waterspouts and Eddies.—The question then is reduced to this, viz., whether, when in the middle of the most profound calm these destructive waterspouts are seen to appear, the form of which corresponds so well to the eddies formed in streams of water, we can point to any current by which the phenomenon has been originated. Now this is precisely what we intended to set in strong relief in describing the general currents of the atmosphere. The counter-trades clearly show that there exist above our heads unmistakable currents of air in motion. Without even recurring to considerations of this nature, it is enough to cast our eyes over the heavens on the appearance of a waterspout, in order to see by the march of the clouds that in spite of the calm below, powerful horizontal currents prevail aloft, which, as their different parts cannot advance at the same rate, must consequently give rise to whirling movements of a more or less decided character. If one of these whirls meet with the favourable circumstances so often seen in water-streams, it will be regularly developed by taking the form which analysis assigns to it; by its downward movement it will even penetrate through into the calm strata, the resistance of which will gradually alter its form and its course, and end by reaching the ground. This simple notion of the mechanical identity of gyrations, whether of liquids or gases, furnishes at once the explanation of phenomena which meteorologists have laboured to find in an entirely different range of ideas. Waterspouts contain powerful forces in action, because they draw the force from a medium above, where it is in abundance; they march onwards because they follow the current which originates them; at their base they are slightly curved, not forwards but backwards, because the comparatively still medium they traverse offers a certain amount of resistance; they act nevertheless in the same manner both on the ground and over water, whatever be the curvature of the conical tube which descends from the clouds, because this curvature never interferes with the direction of the axis of rotation of each spiral, but only with the succession of these spirals in space, &c.

This identity of waterspouts in air and of eddies in water, which is so complete in a mechanical and geometrical point of view, is no longer to be looked at altogether from the physical standpoint, on account of the differences which in this respect exist between water and gas. Indeed, the temperature of a stream of water is almost the same at all depths; in the air, on the contrary, heat decreases markedly as we rise to the higher strata. Further, the moisture of the air is liable to be condensed for a fall of temperature often very slight. Thence the cold air of the high regions, drawn gradually downward by the whirling movement into the low and moist strata, generates a thin mist all round the waterspout. This mist serves as an outer envelope or sheath, the form of which is more or less sharply marked, being rendered visible by its opacity. There is no doubt that the air in its descent is subjected to an increasing pressure and gradually rises in temperature; but it is lower than the temperature of the surrounding air, and it is enough if it falls to the dew-point of the general mass of air surrounding it in order that the nebulous sheath may be immediately produced. If the difference of the two temperatures is insufficient, or if the humidity is too low in any particular stratum, the misty sheath will not be formed, and the waterspout will in part be invisible. None the less, however, will it be there, though it seem cut in two, or appear only in its upper part in a truncated form. This is the appearance so often presented by waterspouts at their commencement, when the upper and lower portions are seen, but not the intermediate portion. Soon these detached portions meet, the outside sheath completing itself as the stratum traversed by it becomes slightly more humid, or as the air whirled more rapidly downwards by the waterspout becomes slightly colder than the air it meets.

Just as happens in the case of the water which gradually descends down an eddy in its whirling course, the air, which gradually descends with a violent whirling motion down the waterspout, escapes from it on coming into contact with the ground, and thereafter rises again in an irregular manner outside the waterspout. But the volume of air which enters into ordinary waterspouts is far from being sufficient to give rise, at a distance, to a wind of any appreciable force; it is only in proximity to and immediately around the base of the waterspout, where this irregular upward movement of the air manifests itself by the ascent of the dust or spray already raised by the lower spires of the meteor. The base of the waterspout is then enveloped in a sort of confused cloud ceaselessly renewed, unless the end of the waterspout ceases to reach down to the ground. This is especially the case when a waterspout suddenly meets a valley in its course; its lower end goes on lengthening, and with little delay is again joined with the ground; but if the movement of translation is too rapid, it will not resume its destructive work till it has cleared the valley and gained the opposite higher ground. Thus in gases as in liquids, whirling movements observe exactly the same laws. The idea is simple and clear: let us, then, without hesitation, put it in place of that of an aërial column with boundaries formed doubtless of misty vapour, but really treated as solid and impenetrable like the crystal spheres of antiquity, through which the cloud draws up the water of the sea, trees, and other objects; or, to put it differently, through which a centripetal updraught violently draws skywards sea-water, trees, &c. In accordance to our idea, all becomes clear and simple in the history of waterspouts; with prejudice, on the other hand, all remains astounding, incomprehensible, and contrary to the simplest notions of mechanics. There, are, however, two points of detail yet to be discussed: we have to return to the appearances from which eye-witnesses have drawn such remarkable conclusions, and to the part played by electricity, a force which meteorologists, till quite recently, were always so ready to resort to in the explanation of phenomena.

As the purely physical appearances of waterspouts differ widely from each other, some have failed to observe the slightest trace of an internal movement; others have attributed to them a descending movement without rotation; and lastly, others, and these the most numerous attribute to them a whirling ascending movement. A little reflection easily explains these contradictions. What is seen and what is related by eye-witnesses whose impressions are vitiated by old-standing prejudice, has no reference to the waterspout itself, which, like air, is transparent and invisible, but to its external envelope of mist, which is more or less opaque. The envelope is exterior, we repeat; it does not therefore partake in the internal gyrations, which, moreover, are too rapid to be visible. Only the surrounding air which is brought into contact with the waterspout is rapidly drawn from some distance by lateral communication with the whirling movement, the result of which is a sort of whirling or spiroidal agitation in the outside sheath of the waterspout. The degree in which movements of this sort favour illusion is well known. It is thus that the slight movements of the cilia of rotifers have the appearance of a rapidly revolving wheel, and the simple rotation of a spirally-cut cylinder of glass produces the impression of a flowing stream of water. Further, the air which is thrown out at the base rises again outside the waterspout. The aqueous vapour imperfectly condensed in the outside of the sheath has itself an ascending tendency sufficient to raise some of the small cloudlets of mist found there. Here are the real movements, complex and changing, but slow enough

* Concluded from vol. xii. p. 538.

to be visible. The illusion of the observer lies in attributing to the interior of the waterspout the movements which really take place round and outside its exterior margin.

The part played by electricity has been thus stated by Peltier, who supposed he had detected traces of this force in the well-known waterspout of Monville. The sheath of vapour is in some sort a continuation of the electrically-charged clouds; it forms a long conductor of about eight hundred feet between the clouds and the ground, a conductor doubtless very imperfect, but on a great scale, and capable of affording to some extent a passage to the electricity. It is, however, far from being comparable with the destructive characteristics of the thunderbolt. The way in which trees overturned by whirlwinds are sometimes broken up has been recognised as resembling more or less that of trees struck by lightning and shattered into splinters; but this effect is only the result of the violent torsion exerted by the gyratory movement of the whirlwind, and not of the sudden passage of an electrical current. Men and animals have often been caught by whirlwinds and injured, without ever experiencing the least electrical shock.

Thus the essential characteristic of these remarkable movements which produce waterspouts or great tornadoes is a circular gyration, the spirals being slightly inclined to the horizon. Wherever you make a section of it, you only find there concentric circles with the radii always converging towards a centre. In representing them geometrically you need not hesitate between the circular diagrams of Reid, Redfield, and Piddington, and the diagrams with converging rays of some learned meteorologists, the victims of a hypothesis and old prejudice. The former diagrams reproduce the mechanical phenomenon in its essentials; the latter answer to a mere illusion which a little reflection should ages since have exploded.

Extension of this Identity to Cyclones.—The last step only remains to extend these conclusions to great tornadoes, that is, typhoons, and lastly to cyclones, which often overspread a vast extent of territory. It is one of the characteristic properties of the eddies generated in currents of water, that they are formed on every scale, even the largest, without undergoing any essential change. Eddies may be a few inches in diameter, a few yards, a few furlongs, or even of still larger dimensions; it is the breadth of the currents where they are generated which alone limits their size. In the ocean there are gyrations on a still vaster scale, or even on a scale altogether colossal, such as the vast currents of the Atlantic which circle round the calm region of the Sargasso Sea. The sun presents the phenomena of whirling movements still better defined and of all dimensions, from large openings equalling our cyclones, even to those large spots which are five or six times greater than the earth itself. In like manner, in the whirling movements of our atmosphere are found small, short-lived eddies of a few feet in diameter, whirlwinds and waterspouts, which last longer, from 10 to 200 yards across, and tornadoes from about $\frac{1}{3}$ to $1\frac{1}{2}$ mile in diameter. Beyond this the eye cannot take in the forms of the whirling columns; these receive another name, but in all essential points they remain the same. When the dimensions are still greater, the diameters measuring 300 miles and upwards, they bear the name of hurricanes or cyclones; but notwithstanding this, their mechanism remains unchanged. They are always gyratory, circular movements increasing in velocity as they near the centre; are generated in the upper currents of the atmosphere, through the inequalities of their velocities; are propagated downwards through the lower strata in spite of the calm or independently of the winds which there prevail; ply their destructive energy when they reach the obstacle offered by the ground; and follow in their march the upper currents, so that the track of their devastations marks out on the surface of the globe the route of the viewless currents of the upper regions of the atmosphere.

There is, however, a difference between whirlwinds and tornadoes on the one hand, and typhoons and hurricanes on the other. As regards the former, note in the first place, the upper portion (*embouchure*), which is a sort of truncated cone inverted and very much widened out above, and in the second place the descending column which prolongs the meteor even to the ground. If the atmosphere was a gaseous mass of air of indefinite height like that of the sun, cyclones would always present these two features. As regards cyclones, however, the ground is very near in proportion to the extent of area they cover, and is reached before they can be subjected to the prolonged contracting process seen in waterspouts and whirlwinds. A cyclone is then a vast whirlwind, but reduced by the obstacle offered by the ground, to the upper part, or to what may be called the funnel-shaped portion of the phenomenon strictly so called. Thence, doubtless, the constant presence in the former of a calm space about the centre, of which the analogue is to be found only in the circling movements of the ocean on their grandest scale; and thence also certain important peculiarities of cyclones to be more particularly insisted on, after having examined the movements of translation of these phenomena.

Course of the Upper Trade Winds.—When the attention is directed to whirlwinds which appear most frequently to be accidental phenomena of short duration and merely superadded to other phenomena of a more general character and much more lasting, it must be allowed that the short lines marking out their course have scarcely been studied from a geographical point of view. These lines probably follow no simple law. In this respect it is otherwise with cyclones; their course recurves, as we saw at the beginning of these articles, on the globe in accordance with a particular law the constancy of which Fig. 2 (vol. xii. p. 402) reveals at a glance. From this chart, the upper currents, whence cyclones derive their origin and mechanical power, do not proceed directly from the equator to the poles. They are deflected at the outset toward the west, then toward the east, thus describing over the surface of the globe parabolic curves whose apices lie somewhere within a few degrees of the polar limits of the surface trade-winds. Clearly these upper currents, which are true aërial rivers, ought to form a part of the upper trades whose existence is assumed, but their actual course is not directly known. If this assumption be correct, then Fig. 2 presents at once the projections of the double system of trades and counter-trades over both hemispheres; and it only remains to explain the singular recurving course taken by the upper trades. This explanation we shall attempt, though the question lies a little out of our way.

If the atmosphere were withdrawn from the influence of the solar heat, it would remain in equilibrium; its successive strata would arrange themselves according to surfaces of level, and would become part and parcel, so to speak, of the solid globe itself; at least it would, even as regards the highest strata, exactly follow the earth's rotation. The effect of the solar heat is constantly to disturb this equilibrium, by the introduction of movements which are the more curious inasmuch as they do not essentially destroy the normal stratification of the strata of the atmosphere. The air incumbent over the hemisphere actually facing the sun is expanded in its lower strata, where the opacity arising from dust floating in the air, and above all the aqueous vapour, absorbs a large part of the heat-rays of the sun. The intervention of this aqueous vapour which ascends vertically from stratum to stratum, has in a special manner the effect even of rendering the diurnal variation of temperature perceptible at heights at which it would not be felt if the air was dry. The maximum of

this general dilatation in the torrid zone takes place under the vertical rays of the sun. In this manner the centre of gravity of the lower strata rises vertically; these raise the strata above them, which being specifically lighter, dry and transparent, are consequently less sensitive to the sun's rays. All the strata in succession, thus thrust upward above their surface of normal height, tend to flow with accelerated motion along these surfaces in the direction of the two poles, where the temperature is relatively low. This effect is still further increased by the peculiar march of the aqueous vapour which is principally condensed about the poles, whence it returns to the equator by another way than that of the atmosphere, viz., along the surface of the earth in the liquid state.

The atmosphere cannot exactly follow the diurnal rotation. A half of its mass, or from about 30° lat. S. to 35° lat. N., lags somewhat behind, since all the molecules in this region being thrust upward describe circles continually increasing in size with the linear velocity from the lower level from which they started in their ascent. To this retardation must be superadded that of the surface trades resulting from their general flow towards the equatorial region. Beyond the tropics, on the contrary, in the temperate zones where the air advances into parallels of latitude continually diminishing in size, the other half of the atmosphere flows in advance of the earth's rotation. Towards the polar circles this advance is converted into a circling movement round the two poles from west to east.

The unequal distribution of land and water over the globe modifies this general aërial current, so that it does not flow on in one current, but is broken up into many currents—the equalities of the surface throwing the current of the counter-trades into several currents more or less distinct from each other. We can easily imagine the behaviour of the counter-trades by combining their march toward the poles with the two opposite transverse tendencies of which we are about to speak. Between the tropics, the resulting currents do not blow straight to the equator, but wear round more toward a westerly direction. Beyond the tropics, they do not blow directly toward the poles, but take a course inclined more to eastward. The two following figures will explain our meaning :—

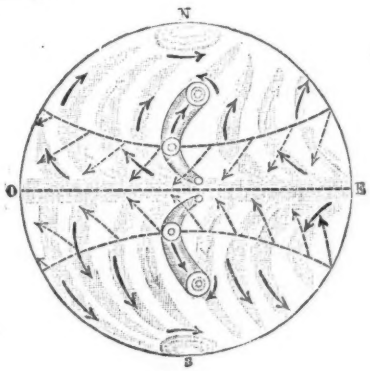

FIG. 13.

Fig. 13 represents the whole upper currents for both hemispheres on a projection of the meridian; and Fig. 14 for the northern hemisphere on a projection of the equator. The dotted arrows mark the surface counter-currents; in other words, the trade-winds blowing obliquely towards the equator, making nearly a right angle with the upper trades of the torrid zone. A slow whirling movement may also be seen around both poles resulting from the counter-trades. These really exist, for the meteorologists of the United States have recently described them under the name, a little fanciful, perhaps, of polar cyclones.

The aërial rivers which are marked out in the midst of these great movements, by which the equilibrium, incessantly disturbed, tends constantly to re-establish itself, exhibit then precisely the course which we have recognised as a peculiarity of the trajectories of cyclones, whilst the surface-trades have no relation to these same curves showing the courses of cyclones. This agreement is a further proof that cyclones must have their origin in the upper

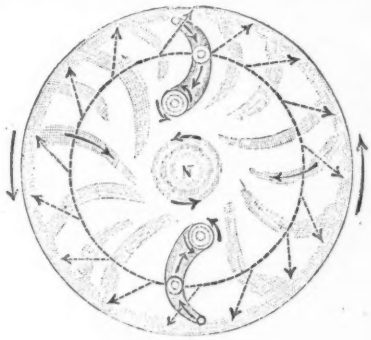

FIG. 14.

regions of the atmosphere, and thence descend even to the ground, and in doing so traverse strata of air either calm or in motion, in such a way as to be totally independent of the cyclone—a state of things incomprehensible on any other hypothesis that has yet been advanced. As to the direction of rotation of cyclones, it results from it that, in these currents strongly recurved, the velocity goes on diminishing transversely from the concave side to the convex side. The zone of calms would then no longer accord with the phenomena of an ascending updraught, but with a maximum of dilatation to the right and to the left of the place where the movement toward the poles commences. Lastly, the mean velocity of these currents, feeble at first in the neighbourhood of the equator, would go on accelerating just as the velocity of translation of our cyclones.

Segmentation of Cyclones.—Whatever may be thought of these opinions regarding the march of the upper trades, of which the surface-trades are the counterpart, it is impossible to doubt that cyclones take their origin from these currents. Let us then look more closely at these gyratory movements. If the maximum height of these trades be from 33,000 to 40,000 feet, and the lower diameter of the gyratory movements, or cyclones, where they meet the ground, from 120 to 180 nautical miles, it will be seen that cyclones must have a figure very different from waterspouts and tornadoes, whose proportions are altogether different, since the height of these last is enormously disproportioned to their lower diameter. Piddington was therefore right in comparing cyclones to mere whirling discs. It would however be more correct to regard them as waterspouts reduced to their upper funnel-shaped portion, or deprived of their slightly conical column, which descends even to the ground. As it advances, the generating current is lowered a little; the vertical height of the cyclone is thereby as much diminished, its section enlarges by contact with the ground, and the disc becomes even more flattened out.

This being granted, if any whirling movement encounters resistances, or if the general current exhibits differences of velocity in different places, it is in the upper regions of the atmosphere especially that these disturbing causes will act most powerfully on the phenomenon, because the velocities are there less, and the distances traversed by the currents enormous. Below, on the other

hand, where the column is narrowed to a very great extent, and where the velocity of the gyrations is excessive, the obstacles met with exercising little influence, are instantly reversed or overcome. Waterspouts acting by the lower extremity, at a distance from their funnel-shaped top (*embouchure*), undergo no change; but cyclones will not withstand the forces brought into play so easily.

Let the modifications thus induced by external causes be what they may, the preceding theory shows that they are possible, and that the rigorously circular movement enunciated by the authors of the "Laws of Storms" allows of perturbations more or less local, and more or less marked, for the simple reason that the whirling movements, which in the case of cyclones are reduced to their upper portions and are therefore little more than mere discs, are very easily modified. It is this, moreover, which explains the deviations from the rule that are found in even the earliest writings of the authors of the "Laws of Storms," as, for example, in Fig. 1 (vol. xii. p. 401), representing the Cuba hurricane, where, notwithstanding the general agreement of the arrows showing the wind with the purely circular theory of storms, there also occur several local deviations.

What can these perturbations be? How can a gyratory movement be changed under the influence of a given external cause? What happens if the velocities of the generating current undergo local changes? It would be as difficult to answer these inquiries *à priori* as it would have been to foresee, before the development of the mechanical theory of solid bodies, the astonishing results of an external force brought to bear on them; but the study of other whirling movements more within the reach of observation, and directed to the sun, has shown that a cyclone is not arbitrarily deformed in any manner whatever. Segmentation, or breaking up of the cyclone, is the last term of the alterations which it can undergo. Then the fragments into which it is broken up tend to assume the form of cyclones, each as perfect as the one from which they were formed, and they follow routes differing but little from each other and describing nearly the same trajectory, but at a distance from each other. This segmentation of cyclones occasionally occurs in the case of the thunderstorms which advance on France from the Bay of Biscay, of which the thunderstorm of the 9th of March, 1865, so well described by M. Marié-Davy, may be cited as an example. A like process of segmentation cannot take effect unless the primitive cyclone in some part and for some time deviate from its rigorously circular form. The tendency to keep this form maintains the ascendency sometimes, but if it begins to give way in a large cyclone, the result is a breaking up of the cyclone itself into segments.

It would be easy to adduce numerous cases in which whirlwinds, tornadoes, and cyclones appear in groups about a given point, or at least follow each other with rapidity. The evidence all goes to show that they are most frequently the result of the phenomenon of *segmentation*, so called from the term used in natural history to designate the process by which some of the lower animals are divided into segments each of which soon becomes a complete animal of itself. But it is in solar cyclones where this mysterious operation can be best followed step by step. Thus a circular sunspot may be seen gradually undergoing the process of deformation, then breaking up into parts, and ending by giving birth to other spots, which precede the original one in a row and at some distance, proceeding at the same pace and reproducing on a small scale the features and behaviour of the primitive type.

Conclusion.

The laws of storms, the statement of which in absolute terms ignores the modifications we have indicated, are therefore in reality only an approximate enunciation, just as are Kepler's laws, to which we have more than once compared them. Kepler's laws would be rigorously exact if we could leave out of account the action of the planets on each other and on the sun; but this being impossible, these laws are not an adequate expression of the truth. The same holds good with respect to the laws of storms. They would also be exact if the currents of the atmosphere never exerted any disturbing action, and as the laws take no account of these disturbing actions, and do not give the means of foreseeing them, or at least of measuring their effects, it would be a mistake to apply them blindly in practical affairs.

It was not by substituting the *cassinoïde* for Kepler's ellipse that science made progress; in like manner it will not be by the substitution of centripetal diagrams of storms for circular diagrams that navigation will be rendered safer. If we have succeeded in giving the true theoretical interpretation of these laws, it must be granted that the time has not come to abandon them, but rather to make them more complete.

To sum up, there are no centripetal waterspouts, whirlwinds, typhoons, or cyclones. The *moveable* forces of aspiration formed, as is said, over the heated ground of the tropics, do not transport themselves with their accompanying updraught to a distance of 700 or 800 leagues over the cold soil of high latitudes, and they have never determined the whirling movements of our atmosphere. The Laws of Storms are in general accord with the mechanical theory of these movements. The rules of navigation which are deduced from them, merit in ordinary cases the confidence sailors have had in them for the past thirty years. The exceptions should be only regarded as mechanical disturbances of the gyratory movement, the further study of which seems destined to complete a first and happy approximation to the truth. The discovery of the approximate laws of storms is one of the finest scientific conquests of this century, and if a closer approximation is to be made, it will be by a more careful study of solar cyclones.

Formerly whirling movements played an important part in our general conceptions of the universe. Fallen into disrepute by a very natural reaction from a false idea, they have been too much forgotten; therefore when at a later period a gyratory character was recognised in the great movements of the atmosphere, an effort was made with one consent to connect them with totally different causes. Geometricians seemed to class them among those irregular movements of which nothing could be made. We see, however, that movements of the cyclonic order constitute in truth a vast series of regular and stable phenomena, of which their perturbations even exhibit a behaviour in accordance with geometric principles. This series which begins with simple eddies in our streams of water, embrace the most singular as well as the most dreaded phenomena of the atmosphere, together with the vast movements which observation reveals in the sun, and extends even to the nebulæ, the structure of which Rosse's telescope has proved to be characterised by whirling movements. It is therefore most desirable that the theory of these movements should be again included in the domain of applied mechanics. The first step to this end is an empirical investigation of their laws, and this work the eminent authors of the "Laws of Storms" accomplished thirty years ago.

NOTES

Two members of the British Ornithologists' Union, Messrs. Harvie-Brown and Henry Seebohm, have recently returned from a most successful expedition into Northern Siberia. Leaving this country early in the spring of this year, they arrived at Ust Zylma, on the Petschora River, in the middle of April, after travelling overland from Archangel. They remained there

until the breaking up of the ice in the beginning of June, when they took boat to Alexievska, and made this their head-quarters for some time. Of the most important ornithological acquisitions amongst more than 1,000 skins, are the young in down together with the eggs of the Little Stint and Grey Plover, the eggs (for the first time) of Bewick's Swan, the eggs of *Sylvia middendorfii* and *S. borealis*, the eggs of *Motacilla citreola*, the eggs of the Smew, and a new species of Pipit. These specimens will be exhibited by Mr. Seebohm at the next meeting of the Zoological Society on the 16th instant.

THERE are three professorships in Trinity College, Dublin, which, by the School of Physic Act (40 Geo. III., chap. 84), become vacant at the end of every seventh year from the date of election; but it is also provided that every professor should be capable of re-election. The three professorships are those of Anatomy, of Chemistry, and of Botany. Pursuant to notice in the London and Dublin *Gazettes*, we learn that the latter of these will be vacant on the 23rd of January, 1876, and that on Saturday, the 29th of January, 1876, the Provost and Senior Fellows will proceed to the election. All candidates are required to send their names, with the places of their education, the universities where they have taken their degrees, to the Registrar of Trinity College, Dublin, before the 22nd January, 1876, and for further information are to apply to the Rev. Dr. Haughton, F.R.S., Medical Registrar of the School of Physic. The emoluments of the professor consist of 300*l.* a year, for which he is required to deliver, first, a course of lectures on Botany in the Arts School during each of the three college terms. Michaelmas Term commences early in October, and Trinity Term sometimes lingers on until the month of July. Secondly, a course of not less than forty lectures on Botany in the Medical School, commencing on the 1st of April and ending on the 1st of July in each year. As Curator of the College Herbarium, there is an additional salary of 50*l.* per annum. The professor being his own assistant, the whole work of arranging and sorting this well-known collection, as well as the correspondence incidental to such a charge, falls on the Curator. The fees average, we are informed, a sum of about nine guineas a year, as the lectures are free to all students of the University. The present Professor, Dr. E. Perceval Wright, being eligible, is a candidate for reappointment.

HIS Excellency the Lord Lieutenant of Ireland has been pleased to appoint Dr. John James Charles to the chair of Anatomy in the Queen's College, Cork, vacant by the resignation of Dr. Corbett. Dr. Charles was a pupil in the Queen's College, Belfast, and is a graduate with high honours of the Queen's University in Ireland. For some time he was assistant lecturer to Prof. Wyville Thomson, and for many years he was Prof. Redfern's assistant and demonstrator. Well taught himself, and already a contributor of numerous essays to the medical journals, we anticipate for Dr. Charles every success as a teacher. With Redfern and Cleland as his colleagues, anatomy appears to be well represented in the Queen's Colleges in Ireland.

THE Vienna Academy of Sciences, says *La Nature*, is occupied with a question which concerns all Europe—the decrease of the quantity of water in springs, rivers, and watercourses. A circular, accompanied by a very instructive report, has been addressed to the scientific societies of other countries, inviting them to undertake observations which, in time, may yield useful results. The Academy calls attention to the fact that during a certain number of years there has been observed a diminution in the waters of the Danube and other large rivers, especially since the practice of felling forests has become common. The Austrian Engineers' and Architects' Union are also occupied with this question, and have appointed a Hydrostatic Commission to collect facts and prepare a report. The Danube, the Elbe, and the Rhine have each been assigned to two members, while two others will be occupied with the meteorology relating to the same subject and with the influence that glaciers and Alpine torrents may exercise on the general result. The Commission considers the question urgent, and recommends the immediate adoption of measures to remedy the evil. According to the *Revue des Eaux et Forêts*, it is unanimous in declaring that the prime cause of the disastrous decrease of the water is the devastation of the forests.

WE are informed that Mr. Gould will shortly issue the first and second part of an important work on the "Birds of New Guinea," which will at the same time form a second supplement to the "Birds of Australia," and will contain illustrations and descriptions of several new species not included in the latter work.

AT a congregation held at Cambridge on Oct. 28, it was resolved to establish a Professorship of Mechanism and Applied Mechanics, with a stipend of 300*l.* a year. There are already three candidates, viz.—Mr. James Stuart, M.A., Fellow of Trinity College; Mr. E. J. Routh, M.A., F.R.S., of St. Peter's College; and the Rev. J. C. Williams-Ellis, of Sidney.

THE Board for superintending non-collegiate students at Cambridge give notice that there will be an examination in certain selected branches of physical science for the award of an exhibition granted by the Worshipful Company of Clothworkers, commencing on Thursday, Jan. 13, 1876, 9 A.M. The exhibition will be one of 50*l.* per annum, tenable for three years by a non-collegiate student of the University of Cambridge. Full information may be obtained from the Censor, Rev. R. B. Somerset.

AN interesting paper on "The Influence of the Sunspot Period upon the Price of Corn" formed the subject of a paper by Prof. W. Stanley Jevons, F.R.S., at the recent meeting of the British Association. After alluding to the attempts made by Mr. Carrington to trace a connection between the price of corn and the variations in the sunspots during portions of the last and present centuries, the Professor said that Mr. Schuster has pointed out that the years of good vintage in Western Europe have occurred at intervals approximating to eleven years, the average length of the principal sunspot period. The elaborate collection of the prices of commodities in all parts of England between the years 1259 and 1400, published in Prof. J. E. T. Rogers's "History of Agriculture and Prices in England," appears to afford the best data for deciding whether the sunspot period influences the price of corn. For this purpose, tables of the average prices per quarter of wheat and other grain, expressed in grains of pure silver, were used. Each series of prices was divided into intervals of eleven years, which were ranged under each other and averaged, so as to give the average of the first, of the second, of the third, &c., years, the commencement of the period being arbitrarily assumed. It is found that the price of each kind of produce examined rises in the first four years, but afterwards falls. It is further shown that the *maxima* prices are found to fall into the tenth, eleventh, first, second, and third years of the assumed eleven-year period. These results are to be looked upon as only preliminary, and need further investigation. It is also pointed out that commercial panics have tended to recur during the last fifty-four years in a distinctly periodic manner. The average length of interval between the principal panics is about 10·8 years, nearly coinciding with 11·11, the length of the solar-spot period. If Prof. Balfour Stewart be right in holding that the sunspot variation depends on the configurations of the planets, it would appear that these configurations are the remote cause of the greatest commercial disasters.

THE death is announced, at the age of seventy-eight years, of Sir John Gardner Wilkinson, F.R.S. He was well known for his successful explorations in Egypt, and his archæological and geographical publications. In 1852 he was created hon. D.C.L. of Oxford, was corresponding member of the R.I.A. of Vienna and of the Royal Academy of Turin.

DR. LORRAIN, one of the most popular professors of the Paris Medical Faculty, died from apoplexy a few days ago. The Minister of Public Instruction and all the professors of the faculty were present at his funeral. Dr. Lorrain wrote many excellent works on professional subjects, amongst which we may notice "Diagnostic by Pulsation."

THE resignation of M. Wurtz has been tendered once more and accepted by the French Minister of Public Instruction, and M. Vulpian has been appointed to succeed him as Dean of the School of Medicine of Paris.

THE Observatory of Toulouse has purchased a telescope of eighty-five centimetres diameter, and five metres focal distance, at a cost of 1,200*l*. M. Tisserand is head of the Toulouse Observatory.

PETERMANN'S *Mittheilungen* for November contains the following papers:—On Soleillet's and Largeau's travels in the Sahara and to Soudan, by Dr. Gerhard Rohlfs. The continuation of Weyprecht's "Pictures from the High North," in which he describes the formation of the pack-ice, and gives some forcible illustrations of ice-pressure. Under the head of "Most Recent Travels in Australia," accounts are given of Forrest's journey through W. Australia (1874), Lewis's explorations in the north and east of Lake Eyre, with a map (1874–5), Ross's journey in the S.W. of South Australia (1874), and Giles's journey from Fowler Bay to Torrens Lake. A paper, with map, by E. Behm, on the extension of the Egyptian power on the Upper Nile, treats of the results obtained by Baker, Long, Kemp, and Marno.

IN the *Bulletin* of the French Geographical Society for October is an itinerary of a journey by the energetic Abbé Desgodins in 1873, from Yerkalo to Tse-Kou, both on the river Lan-Tsang-Kang, in Eastern Tibet. It is accompanied by a map of part of Eastern Tibet to the north of Burmah and Yunan, containing the courses of many rivers, and the positions of a large number of towns. There is also a paper, with map, by Colonel Long, describing his journey in 1874–5 to the Victoria Nyanza, and the Niam-Niam country. M. E. Boisse describes a visit which he paid in 1874 to Samoa and a few other Pacific islands.

PROFESSORS Nordenskjöld, Lundström, and Stuxberg, who took leave of the Swedish Arctic Expedition at the mouth of the Yenesei River on the 19th of August last, with the intention of returning to Sweden *vid* Siberia, arrived at Ekaterinburg on October 29, and were to remain for four days.

THE report of the meeting of the Eastbourne Natural History Society for October 15 contains a paper by Mr. F. C. S. Roper, F.L.S., on the additions to the Fauna and Flora of Eastbourne during 1875.

THE Eighth Annual Exhibition of the Haggerston Entomological Society will take place at the Society's Rooms, 10, Brownlow Street, Dalston, on Thursday and Friday, Nov. 11 and 12, 1875, between the hours of 6 and 11 P.M.

FROM the "Proceedings of the Liverpool Naturalists' Field Club" for 1874-5, we find that the Society continues to do a creditable amount of useful work. Ten field meetings were held last summer, and from the way in which these are conducted, the members are likely to derive much benefit from them. The "Proceedings" contain an admirable address by the President, the Rev. H. H. Higgins, well calculated to stimulate those who heard it to an earnest study of science. Mr. Higgins has been presented by the Society with a handsome testimonial in acknowledgment of his long and valuable services as president.

FROM the Tenth Report of the Quekett Microscopical Club we learn that the number of members is 530, and that the Club is in all respects in a prosperous condition.

ANOTHER part of "Figures of Characteristic British Fossils with Descriptive Remarks" has been issued. It will be recollected that Part I. appeared in 1867, II. in 1869, and III. in 1871. These three parts included from the Cambrian to the Devonian forming thirty plates. This new part (IV.) contains plates 31 to 42, and includes "Devonian, Old Red Sandstone, Carboniferous and Permian," completing the Palæozoic division. In addition to the plates giving figures of fossils and the letterpress description, there are descriptive remarks on groups of fossils with woodcuts of recent and fossil forms for comparison.

WE have just received a copy of the report on deep-sea dredging operations in the Gulf of St. Lawrence, by J. F. Whiteaves, dated Montreal, 1874. The ship used was the Government schooner *J. H. Nickerson*, of seventy tons. Four cruises were made. In the first 14 casts of the dredge were made in 110 to 220 fathoms, in the second 16 hauls in 20 to 70 fathoms, in the third 18 hauls, and the fourth 16, in neither of which is the depth stated. A summary of the zoological results is given, the determinations being mostly by Professors A. E. Verrill and S. J. Smith.

WE would recommend to the notice of those of our readers who are interested in the antiquities of our country, a third revised edition of Mr. Thomas Wright's well-known work, "The Celt, the Roman, and the Saxon" (Trübner). It contains a vast amount of information on the pre-Christian condition of England.

AMONG the subjects on which the Council of the Institute of Civil Engineers invite communications and offer premiums is "The Flow of Fluids, liquid and gaseous."

FROM the "Report" for 1874 of the Cardiff Naturalists' Society, established in 1867, we learn that it is increasing rapidly in numbers and prosperity. During 1874 the Committee tried the experiment of introducing scientific and other lectures, and although monetarily they were a failure, in other respects they were so satisfactory that the Committee recommended their continuance for another year. A large proportion of lectures on important scientific subjects were given, and two field meetings were held. The "Report" contains a Meteorological Report for each month of the year, by Mr. F. G. Evans, F.M.S., and also a table of rainfall observations in the Society's field.

THE following papers by Mr. T. Mellard Reade, C.E., F.G.S., have been reprinted from the Proceedings of the Liverpool Geological Society:—"The Glacial and Post-glacial Deposits of Garston and the surrounding District, with Remarks on the Structure of the Boulder Clay;" and "Speculations on the probable Distribution of Land and Sea during the Deposition of the Marine Boulder Clays and Sands."

WE have received an address by Prof. R. H. Thurston, C.E., delivered to the graduating class of the Stevens Institute of Technology (U.S.) It is entitled "The Mechanical Engineer, his Preparation and his Work," and contains some excellent advice, useful not only to young engineers, but to all who have been trained to other mechanical professions. The Stevens Institute, though what we would call a technical college, affords a good general scientific training, with a fair admixture of literary culture, and the object of Prof. Thurston's address is to show that the more complete is the culture of an engineer, the greater is likely to be his professional success.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mr. R. Roberts; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Gibbs; two Lesser White-throats (*Sylvia sylviella*), two Yellow Wagtails (*Motacilla flava*), European, presented by Mr. Augustus E. Field; two Central American Agoutis (*Dasyprocta punctata*) from Central America, presented by Mr. W. G. Davis; a Polar Bear (*Ursus maritimus*), Arctic Regions; a Smooth-headed Capuchin (*Cebus monachus*) from S.E. Brazil; a White-throated Capuchin (*Cebus hypoleucus*) from Central America; a Golden Eagle (*Aquila chrysaëtus*) from Hudson's Bay; two Maximilions Aracari's (*Pteroglossus wiedi*) from Brazil, deposited; two Golden Agoutis (*Dasyprocta aguti*), born in the Gardens.

*ELEVENTH REPORT OF THE COMMITTEE FOR EXPLORING KENT'S CAVERN, DEVONSHIRE**

THE Committee have again the melancholy duty of reporting that death has deprived them of one of their members. As long ago as 1859, as soon as he became aware of the importance of the discoveries made in the Windmill Hill Cavern at Brixham, Sir Charles Lyell expressed a strong desire that Kent's Cavern should also be systematically and thoroughly explored; and it was with his full concurrence that the proposal to do so was laid before the Committee of the Geological Section of the British Association at Bath in 1864, the day after he delivered his Presidential Address, whilst his ardent advocacy, together with that of the late Prof. Phillips, secured its ready acceptance by the Committee of Recommendations and the General Committee. At the first meeting of the Cavern Committee, appointed in the year just mentioned, he was unanimously elected chairman, and he continued to occupy that post until his lamented decease on Feb. 27, 1875. Though the state of his health prevented him from taking any active part in the exploration, his interest in the work never abated; he always carefully studied the Monthly Reports of Progress sent him by the superintendents, and he made careful arrangements for their preservation.

The Tenth Report, read to the Geological Section of the Association at the Belfast meeting, and printed in the annual volume for last year, brought up the work to the end of July 1874. The exploration has been carried on without interruption from that date to the present time; the mode of excavation adopted at the beginning has been uniformly followed; the superintendents have visited the cavern daily; the progress of the work has been carefully recorded in the cavern diary; the workmen have, as heretofore, given complete satisfaction; and Monthly Reports have been regularly sent to Sir Charles Lyell until his decease, and subsequently to Mr. John Evans.

The cavern continues to be much visited by persons desirous of studying on the spot its characters and phenomena; and during the last twelve months the superintendents have had the pleasure of taking a large number of visitors through those branches which have been explored, and of explaining to them the mode of operation. Probably a still larger number have been conducted by the "guide," who, though under the control of the committee, is not permitted to take parties to those branches of the cavern in which the exploration is in progress, or has not been begun.

As in former years, rats have frequently been seen running about in various parts of the cavern, including those in which the men have been at work, though hundreds of feet from any glimmering of daylight; and they have displayed their usual boldness as well as their skill in carrying off candles. In other branches, almost as far from the entrances, where all researches have ceased for some years, their footprints are to be seen in great numbers, especially on the silt left, here and there, where the drip is copious in wet weather.

On Jan. 29, 1875, a "buzzing fly" was seen and heard about 300 feet from daylight.

Clinnick's Gallery:—The Tenth Report (1874) stated that the exploration of Clinnick's Gallery was in progress, and had been completed for about 34 feet; that below the least ancient, or the Granular, Stalagmitic Floor, for a distance of 18 feet from its entrance, a small quantity of "cave earth" uniformly presented itself, beneath which lay the Breccia, occasionally separated from it by remnants of the more ancient, or Crystalline, Stalagmitic Floor *in situ*; but that from the point just named, up to that reached when the Tenth Report was drawn, there was no cave earth, so that the two Stalagmites lay the one immediately on the other, with the Breccia, that is, so far as is known, the oldest of the cavern deposits, beneath the whole.

At the commencement of the exploration of this gallery, the deposits so very nearly reached the roof as to induce the belief that a very few feet at most was all that the workmen had before them. As the work advanced, however, the unoccupied interspace between the roof and floor became gradually larger, until on Aug. 6, 1875, John Clinnick, one of the workmen, forced himself through, and, after proceeding about 50 feet by estimation, entered a large chamber, into which he was followed by one of the superintendents. The chamber, probably one of the largest in the cavern, is beautifully hung with Stalactites, and has numerous Stalagmitic "paps," some of them four feet high, and of almost cylindrical form, rising from a floor of the same material.

Clinnick's Gallery, on being excavated, was found to be a somewhat tortuous passage, varying from four to eight feet in width, and from seven to ten feet in height. That it was once a watercourse there can be little doubt, as the roof bears the marks of the long-continued action of a running stream. The walls vary considerably, being in some places smooth, in others much fretted or corroded, and in others more or less angular.

The objects of interest found in this branch of the cavern during the last twelve months have been by no means numerous; nevertheless, they are not without considerable interest.

Attached to the upper surface of the Granular Stalagmitic Floor portions of three land-shells were found, and about twenty bones of mammals were met with lying together loose on the floor. Their characters imply a recent introduction into the cavern.

Incorporated in the Granular Stalagmitic Floor itself were a few bones, including a humerus, a tibia, and an ulna, each nearly entire, and a portion of a large humerus, all of which had been gnawed.

Though no cave earth was met with beyond the point already specified, there seems no doubt that to the era of that deposit may be referred a considerable portion of a radius and of an ulna, both gnawed and found under loose pieces of stalagmite.

The remains found in the Breccia were four teeth of bear, a few bones and fragments of bone, and three teeth of lion in three portions of, no doubt, one and the same lower jaw. The latter "find" (No. 6,482) is of considerable interest, as being the first known instance of remains of any animal besides bear met with in the Breccia. Though the superintendents had no doubt of the feline character of the teeth, they forwarded one of them to Mr. G. Busk, F.R.S., a member of the committee, remarking that they believed it to be the last lower left molar of *Felis spelæa*, and requesting his opinion on it. In his reply, he remarks: "There is no doubt that the tooth is the left lower carnassial of *Felis leo*, but it is of very unusual size, being, I should estimate, one-twelfth bigger than the average dimensions of that tooth in the lion. It is usually longer, but not so thick, in the tiger than in the lion, but the thickness of the present one is proportionate to its length. Another peculiarity, as it seems to me, is the great wear that the tooth has undergone. I fancy existing lions are not allowed to live long enough to wear their teeth so much. At any rate the Kent's Hole tooth appears to be more worn than any other I have as yet met with. Can it belong to Machairodus?" Having succeeded in removing some part of the matrix encrusting the other portions of the jaw, they were also forwarded to Mr. Busk, with the observation that the superintendents had carefully considered the question before submitting the first tooth, and had come to the conclusion that the jaw was not that of Machairodus, for, waiving the fact that none of the teeth were serrated, the fang of the canine still remaining in the jaw was much too large for a lower canine of any known species of Machairodus; and it was suggested that it might be worth considering whether the specimen belonged to any of the species of *Felis* found in the forest-bed of Cromer. To this Mr. Busk replied: "The jaw does not appear to present anything unusual. It is, however, a good example to show that the cave lion lived to a good old age."

The Breccia in Clinnick's Gallery also yielded seven specimens of flint and chert, none of which need detailed description.

The comparative paucity of specimens induced the superintendents to suspend operations in that direction for at least a time. The labour of seven months had been expended on it,

* Abstract read at the Bristol meeting of the British Association.

during which the exploration of the gallery had reached seventy-five feet from the entrance, where the great chamber discovered by Clinnick may be said to begin.

The following is a complete list of the objects of interest found in this gallery from first to last:—Three shells of Helix and about twenty bones of mammals lying on the upper surface of the Granular Stalagmite; a few gnawed bones incorporated within this stalagmite itself; eight teeth of hyæna and two of fox, a tolerable number of bones and fragments of bone, one large chert implement, and one small flint flake, in the cave earth; and ninety teeth of bear and three of lion in portions of a left lower jaw, a large part of a skull, numerous bones and portions of bone, a flint pebble, and eleven specimens of flint and chert implements, flakes, and chips, including the very fine tool, No. $\frac{1}{6411}$, in the Breccia.

The Cave of Inscriptions.—The chamber in which the Long Arcade terminates has been called "The Cave of Inscriptions," from the number of names, initials, and dates graved on the stalagmite in various parts of it. Besides those on the "Inscribed Boss of Stalagmite" at the entrance of the cave, described in the Tenth Report, inscriptions occur on what is known as the "Hedges Boss" and on the walls of the chamber. There are also a large number of names, &c., smoked on various parts of the roof, as there are, indeed, in almost every branch of the cavern, some of which appear to be of very considerable antiquity. The oldest of the inscribed dates is 1609, and the most modern 1792, but the most conspicuous and most famous of the inscriptions is "Robert Hedges, of Ireland, Feb. 20, 1688."

It was stated in the Tenth Report that the exploration of this cave had been completed up to sixteen feet from its entrance, when it was suspended in order to proceed with Clinnick's Gallery; that the Granular, or less ancient, Stalagmitic Floor was found to be everywhere intact and continuous, and that the Crystalline, or more ancient, Stalagmite lay beneath it; that the latter had been broken by some natural agency, and though in some cases the severed portions remained *in situ*, in others they had been removed and were not always traceable; that adjacent to the left wall of the cave a wedge-like layer of cave earth lay in its proper place between the stalagmites, and was six inches thick at the wall, but thinned out about a yard from it, beyond which the one floor lay immediately on the other. On resuming the exploration of the cave it was found that the state of the deposits continued to be the same up to thirty-four feet from the entrance, with the single exception that the broken blocks of crystalline stalagmite were never dislodged beyond being faulted to the extent of two or three inches. At and beyond the point just specified, traces of the earlier explorers were again met with in almost every part of the cave, but were found to be limited to the breaking up of the stalagmites and the subjacent deposit to the depth of twelve inches at most. A thin layer of typical cave earth extended throughout the entire chamber, and it was obvious that at the time when the deposition of the cave earth commenced the crystalline stalagmite did not exist as a continuous sheet, for in considerable spaces the cave-earth lay immediately on the breccia without any stalagmite between them, and it was not always easy to determine the exact junction of the two deposits. On the discovery of objects of interest at or near this doubtful junction, care was taken to record them as belonging to the "cave earth and breccia," even though, from their own characters, it was usually easy to refer them to their proper deposits and eras respectively.

The Cave of Inscriptions was found to extend upwards of sixty feet from north-east to south-west, forty-five feet from south-east to north-west, and to be upwards of twenty feet high.

Two "finds" only were met with in the Granular Stalagmitic Floor; one consisting of a few bones, including a portion of a large humerus, whilst the other was a very small bone, probably of bat, with bits of charcoal and of coprolite, all lodged in the same hand specimen.

The cave earth yielded four teeth of hyæna, a few gnawed bones, coprolites on several occasions, and one flint flake.

At and near the junction of the cave earth and breccia, where they were not separated by stalagmite, two right lower jaws and four loose teeth of hyæna, thirty-eight teeth of bear, part of a jaw of fox, one incisor tooth of a small rodent, numerous bones and fragments of bone, a somewhat large number of coprolites, and one flint flake were met with. At least most of the ursine remains may be safely referred to the breccia, whilst all those of hyæna undoubtedly belong to the cave earth. One of the hyæna jaws just mentioned contains all its teeth except the inner incisor, but, as is commonly the case with lower jaws of the era of the cave earth, it has lost its lower border and condyles, and is much gnawed. The other jaw of hyæna has lost the two inner incisor teeth and the condyles, and is slightly gnawed, but is otherwise entire.

There were found in the Breccia eighty-two teeth of bear—some of them in jaws or parts of jaws—two of lion, in a portion of right upper jaw, numerous bones and pieces of bone, including part of a skull and several other good specimens, and thirteen implements, flakes, and chips of flint and chert. The lion's teeth (No. 6,518) are the last two molars. The sockets of the canine tooth and of the small tooth immediately behind it still exist, and everything betokens an animal of great size. The specimen, to which a considerable quantity of the breccia still adheres, is peculiarly interesting as being found in a deposit in which careful methodical research, continued for years, had failed to detect any other osseous remains than those of bear, with but one exception, and that, as already stated, being also the lower jaw of a lion, found less than two months before. This interesting relic was met with on 31st December, with two teeth of bear, bones and fragments of bone, in the second foot-level of Breccia. No feline remains have been detected since that date.

A few only of the flint and chert specimens require description:—

No. 6,550 is an implement made out of a well-rolled chert nodule. It is somewhat semilunar in form, but broader at one end than the other, and measures about 4·4 inches in length, 2·3 inches in greatest breadth, and 2·5 inches in greatest thickness, which it attains near the broader or butt-end. It has undergone a considerable amount of chipping, has been reduced to an irregular edge along the greater part of its perimeter, and is comparatively thin near the pointed end. It is very, but unequally, convex on both faces, each of which has a central ridge, and retains the original surface of the nodule over the whole of the butt-end, whence a trace of it extends along the central ridge of the less convex face to about an inch from the point. The portion of the surface which has been chipped is of a yellowish hue, derived, no doubt, from the matrix in which the specimen lay. This, however, is but a superficial stain, as there are indications of an almost white colour within. This fine implement was found 15th February, 1875, between the Hedges Boss and the left wall of the cave, thirty-six feet from its entrance, in the second foot-level below the surface, that is, in the uppermost foot-level of the Breccia, and having no other object of interest near it.

No. 6,565 is a chert implement 3·7 inches long, 2·7 inches in greatest breadth, and 1·7 inches in greatest thickness, which it attains not far from its centre. It has unfortunately lost one of its extremities—apparently broken off whilst the tool was being made. It is very, perhaps equally, convex on each face, but the centres of convexity are not situated opposite one another; and, though made from a nodule, not a flake, no part of the original surface remains. A considerable amount of work has been expended on it, and it has been reduced to an edge all round the perimeter except at the broken end. The marginal edge is neither keen nor regular, nor in the same continuous plane. There can be little doubt that it was intended to be a somewhat pointed ovoid tool, and that had it been perfected its form would have been more symmetrical than the breccia tools are usually, and its colour is whiter than that of most of the implements found in the same deposit. It was met with on 13th April, 1875, in the second foot-level of the Breccia, without any other object of interest near it, forty-seven feet from the entrance of the Cave of Inscriptions.

The earlier explorers had but imperfectly examined the material they dug up in this branch of the cavern. On taking it to the daylight, the committee found in it nineteen teeth of bear, twelve of fox, nine of hyæna, two of horse, and one of rhinoceros; a large number of bones, numerous coprolites, a fragment of a marine shell, and six flakes and chips of flint.

The exploration of this cave was completed on 14th June, 1875, having occupied the labour of between eight and nine months.

The following is a list of the specimens found in it in undisturbed ground, inclusive of those mentioned in the Tenth Report:—One bone of bat, a few other bones, a few patches of coprolite, and a bit of charcoal, in the Granular Stalagmite; twenty-seven teeth of hyæna, several of them in jaws or parts of jaws'

eleven of bear, one of a small rodent, one jaw of fox, numerous bones and fragments of bone, of which six had been charred and a greater number gnawed, a large number of coprolites, and seven tools, flakes, and chips of flint, in the Cave Earth; 213 teeth of bear, some of them in jaws or pieces of jaws, two of lion, in parts of upper jaw, and twenty implements and flakes of flint and chert.

The Recess.—On completing the exploration of the Cave of Inscriptions, operations were at once commenced in a "Recess" occupying its north-western corner, and which was expected to lead to a new external entrance to the cavern. It extends in a north-westerly direction for fully sixty feet, and is of sufficient width for a man to pass easily; beyond this its extent is considerable, but at present it is too narrow for examination. Its floor is a thick sheet of the crystalline or more ancient stalagmite, and is abruptly truncated at the junction of the Recess with the Cave of Inscriptions. It rested on a thick mechanical accumulation, which is unmistakeable breccia, and reaches a higher level than elsewhere in the cavern, so far as is at present known. It was decided to leave intact the Stalagmitic Floor, and in fact to burrow under it; but when the excavation had reached a distance of ten feet, the two walls were found to be so very nearly together as to render it necessary to abandon the work, or to break up the floor and proceed at a higher level. The former course was, though reluctantly, decided on. The only specimens found here were two teeth of bear, a few bones, and an unimportant piece of flint.

The Alcove.—A recess in the eastern wall of the Cave of Inscriptions, near the Hedges Boss, and which received the name of the "Alcove," was next explored. When emptied it proved to be scarcely lofty enough for a man to stand erect, and ten feet in length and breadth, but divided into two compartments by a limestone partition extending nearly across it. Its exploration, which occupied three weeks, was rewarded with thirty-nine "finds" of remains of mammals, including fifty-nine teeth of bear, several of them in portions of jaws; sixteen of fox, all of them in portions of three lower jaws; four of hyæna; numerous bones, including several good specimens, though all of them more or less fragmentary; and one coprolite. The teeth of hyæna, two of the jaws of fox, and the coprolite were met with in cave earth; but the remaining jaw of fox (No. 6,619) was found in the breccia. It was broken into two pieces, which were lying together and contained five teeth, and is the only known relic of the genus in this old deposit. The Alcove contained no trace of flint or chert.

The Great Oven.—A very long, narrow, and low tunnel opening out of the south-western corner of the Cave of Inscriptions has been termed the "Great Oven." Its exploration was begun July 27, 1875, or but four days before the period at which this report closes. It contains a thin layer of cave earth, and a deposit of breccia of unknown depth. The former has already yielded a few traces of hyæna, and the latter a greater number of ursine remains.

On studying the osseous remains found in the Breccia in the branches of the cavern explored during the last twelve months, the following prominent facts arrest attention:—Some of the teeth of bear are those of very old animals and worn almost to the fang. The jaws, though frequently broken, have never lost their lower borders, as is almost uniformly the case with the cave-earth specimens; and none of the bones appear to have been gnawed. In no instance were the bones found lying in their anatomical relations, but different parts of the skeleton were often huddled confusedly together; thus, in No. 6,613, found in the Alcove, a canine tooth adheres to one side of the proximal end of a tibia, and a piece of jaw to another side. Some of the specimens have fretted surfaces, and appear to have been rolled by running water. Many of the bones were broken where they were finally lodged, and the parts, with little or no displacement, reunited with stalagmitic infiltration. Others appear to have been flattened, or more or less crushed, where they lay. Occasionally, in the same rock-like mass of breccia were found bones of very different colours, showing that mere colour is no test of age.

Nor are the remains from the cave earth void of instruction. Up to the present time, wherever the cave earth has been met with, there also have traces of the hyæna been found, either in the form of parts of his skeleton, or his coprolites, or bones scored with his teeth-marks, or jaws divested of their lower borders, or long bones broken after his well-known fashion. But though everywhere present in greater or lesser numbers, these traces became less and less plentiful with increased distance from the external entrances of the cavern, and were very "few and far between" in the chamber most remote from the entrances. Whilst remains of the hyæna were thus met with wherever the cave earth occurred, they were accompanied in the interior by very few of his contemporaries. Thus, whilst the chambers adjacent to the entrances contained teeth and bones of horse, rhinoceros, deer (several species), bear, fox, elephant, ox, lion, wolf, and hare, as well as hyæna—the last being by far the most prevalent—remains of the hyæna alone have been found during the last twelve months. Nor is it without interest to note the branches of the cavern in which remains of the different forms just enumerated were last detected on the way to the Cave of Inscriptions. The hare was not found anywhere in the western division of the cavern—that of which the Cave of Inscriptions is the innermost chamber; the badger, wolf, and ox were represented in the "Charcoal Cave," but not beyond it; and relics of horse, rhinoceros, deer, bear, fox, elephant, and lion did not appear beyond the Long Arcade. Finally, no traces of Machairodus have been met with since the incisor tooth, found July 29, 1872, and described in the Eighth Report, presented at Brighton.

SCIENTIFIC SERIALS

Proceedings of the Berwickshire Naturalists' Field Club, vol. vii. No. ii.—This earliest of Field Clubs continues to sustain the high reputation it has had from the beginning; the present part of the Proceedings shows that the members continue to investigate diligently and to good purpose the natural history and antiquities of the interesting district which forms their field. Most of the papers are of real value, and the best service we can render the club and our readers is to give a list of them:—"On supposed lake or river-terraces near Kelso," by Mr. T. Craig; "On Jedburgh Pears," by Mr. James Tate; "On the antiquity and history of some Border Pears," by Mr. Jas. Hardy; "On evidences of ice-action in Berwickshire," by Mr. W. Stevenson; "Ornithological notes," by Mr. H. Gibb; "On the value of the horse-chestnut (*Æsculus hippocastanum*) as a timber-tree in plantations," by Mr. R. Carr-Ellison; "On Lepidoptera, taken mostly in 1874," a list of captures by various members; "On the signification of some names of places in South Northumberland," by Mr. R. Carr-Ellison; "On the occurrence of the Wild Cat in the border district," by Mr. James Hardy; "A list of local plants and their localities," by Mr. A. Brotherston; "Ornithological notes," by Mr. R. Gray; "On iron and iron slag found at Worm Law and Yeavering," by Mr. Jas. Hardy; "On some flint implements of prehistoric people in Berwickshire," by Mr. James Hardy, with some beautifully executed illustrations; "A note on a specimen of *Arabis turrita*, discovered at Haining," by Mr. A. H. Borthwick; "On ancient stone cysts and human remains discovered at Aycliffe House, near Ayton," by Mr. J. Hardy, with an illustration; "On a bronze celt found at Linden," by Mr. R. G. Balam, with an illustration; "Some notes on the movements of migratory birds," by Dr. Scott and Mr. Hardy; "Zoological notes," by Messrs. Ferguson and Brotherston; various information on local natural history, by Mr. Hardy; "On some of the birds of Lauderdale," by Mr. A. Kelly; "List of *Araneidea* and *Phalangidea*, collected from Oct. 1871 to Dec. 1874, in Berwickshire and Northumberland, by Mr. James Hardy," by the Rev. O. P. Cambridge; "On Berwickshire insects," by Mr. Hardy, who also has "Contributions to the entomology of the Cheviot Hills."

Third Report of the Winchester College Natural History Society.—This report is altogether very encouraging; it has, as the preface justly states, "a real amount of active and intelligent life" to record during the year. The members as a body seem to be really interested in the work of the Society, and the tendency of that work is evidently to train the members to be accurate observers and independent thinkers. In the preface considerable importance is rightly attached to the collection and exhibition of specimens at the meetings for examination and comment, especially with the view of encouraging the younger members to become intelligent collectors. The report contains a considerable number of papers, nearly all by present or past members, and these papers give evidence of real intelligence, honest study, and in some cases of original observation. The first paper especially, that by W. A. Forbes, is highly creditable to its author; G. L. Hawker's, on Bio-geology, shows considerable knowledge and not a little originality of conception; the paper by N. M. Richardson also deserves mention. But indeed

the papers as a whole are above the average of those emanating from similar societies. The lists of specimens in the various sections appended show that the members continue to do much practical work; a botanical garden has also been opened in connection with the Society.

Proceedings of the Bath Natural History and Antiquarian Field Club, vol. iii. No. 2, 1875.—This part contains the following papers on scientific subjects:—Notes on some railway sections near Bath, by the Rev. H. H. Winwood, F.G.S., with an illustration.—Studies and problems for Somersetshire geologists, by M. H. B. Woodward, F.G.S.—There is an interesting address by the Rev. Preb. Scarth, on the results of modern archæological achievement, and a summary of Proceedings for the year 1874-75, by the Secretary.

Morphologisches Jahrbuch.—The first part of this new Journal of Anatomy and Embryology, issued by Prof. Gegenbaur (see vol. xii. p. 15) consists of about 200 pages, and has five double plates. Prof. Gegenbaur supplies an excellent introductory article on the position and signification of morphology. The succeeding sixty pages are occupied by an elaborate account, by Dr. Richard Hertwig, of *Podophrya gemmipara*, a new species of Acinetan, followed by an essay on the structure and systematic position of the Acinetæ. The author identifies his species with one figured, but not determined, by the late Mr. Alder in the "Annals of Natural History" for 1851, p. 426. Its nucleus is remarkable for having a number of irregular stellate branches, and its tentacles are differentiated into captorial and suctorial. After a review of the structure of Acinetæ generally, Dr. Hertwig comes to the conclusion that a unicellular organism, covered with cilia, is the original form from which Acinetæ and Infusorians have sprung, but that it cannot yet be determined whether it possessed a cytostome, and thus was a true ciliated Infusorian, or whether it was provided with tentacles, and was intermediate between Ciliata and Acinetæ.—The whole of the remainder (114 pages) of this part is occupied by a very notable paper by Dr. Emil Rosenberg, on the development of the vertebral column and of the os centrale carpi of man. He sets before himself the problem, little touched hitherto, of the discovery of the steps by which man may have developed from the nearest mammalian stock. Taking first the vertebral column, he sets forth the differences existing therein in the various Anthropomorphæ, and seeks to reconcile them with that of man. For instance, in two genera, Troglodytes and Hylobates, there are thirteen dorsal vertebræ, while in the Orang and in man there are only twelve. But Dr. Rosenberg has discovered in more than one human embryo an actual rib-rudiment on the 13th dorsal vertebra; so that the homology of the 13th dorsal in man and Troglodytes is established. Another result that Dr. Rosenberg claims to have demonstrated from examination of human embryos is that a process of transformation goes on in the growth of the sacrum, by which vertebræ at the proximal end, with their costal elements, are assumed into the sacrum, while a corresponding number at the distal end undergo reduction and are dismisssd into the caudal region. And this process, generalised, may be applied to each of the hinder regions of the vertebral columns. Thus in the history of development each lumbar vertebra in man is the result of a single transformation from the condition of a dorsal vertebra; each sacral vertebra has previously passed through the lumbar stage; while the caudal vertebræ have been successively dorsal, lumbar, and sacral, before becoming caudal. This is necessarily but a very imperfect sketch of the major subject of this paper, which is of very high interest.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, Oct. 26.—M. Frémy in the chair.—In opening, he referred in feeling terms to the death of Sir Chas. Wheatstone.—M. Milne-Edwards presented the second part of the eleventh vol. of his work on "The Comparative Physiology and Anatomy of Men and Animals." The following other communications were made:—On employment of means in experimental physiology, *dpropos* of the influence of stripping the leaves off the beet, upon the production of saccharine matter, by M. Cl. Bernard. M. Frémy made some remarks also on this subject.—On the carpellary theory, according to the Irideæ (third part), by M. Trécul.—On the dates of fall of meteorites, by M. Sainte-Claire Deville. He finds an excessive fall of bodies on the 12th, 13th, and 14th May; also something like a ten-days' period, corresponding to periodical inequalities of temperature.—On the practical value of steam-injectors, by M. Ledieu.—Progress realised, in the question of making land, by employment of the rational method, and in determination of the daily working of chronometers, by M. de Magnac. The new method (he shows) renders navigation much more exact.—Magnetic observations on the island of St. Paul, in November and December 1874, by M. Cazin.—On the mosses of St. Paul and Amsterdam Islands, by M. Bescherelle.—List of Lichens collected by M. de l'Isle, on St. Paul and Amsterdam, and description of new species, by M. Nylander.—New spectro-electric tube (modified fulgurator), by MM. Delachanal and Mermet. A small conical capillary tube is placed over the platinum electrode passing through the bottom of the larger tube; through this the liquid rises and is illuminated by the spark.—On the laws which govern reaction with direct addition (continued), by M. Markovnikoff.—The industry of nitrate of soda in South America, by M. L'Olivier.—Experimental researches on the mechanism of coagulation of blood in treatment of varices by simple isolation of veins, by M. Bergeron.—On the alterations produced in the vine by *Phylloxera vastatrix*, by M. Max. Cornu.—Conservation of food stuffs, by M. Reynoss.—M. de Carvalho presented a note on the properties of air subjected to passage of an induction current.—M. Delauney on a "solar concentrator," *àpropos* of M. Mouchot's paper.—M. Pertinset on a project of exploration of Terra del Fuego.—The Minister for the Navy and Colonies communicated part of a report from the Governor of Martinique on the earthquake there from 17th to 25th September, and magnetic phenomena accompanying it. M. Sainte-Claire Deville said M. Duvignan had written him from Guadeloupe that none of the Martinique shocks had been felt there.—Observations of the planet (149) discovered by M. Perrotin at Toulouse (sent by M. Leverrier).—Experiments made on Geissler tubes with the chloride of silver pile formerly described, by MM. Warren De la Rue and Müller.—On spiral nebulæ, by M. Planté. He shows how a cloud of metallic matter detached from the electrode by an electric current of high tension, in a liquid, assumes a gyratory movement when acted on by a magnet; and supposes the form of spiral nebulæ may thus be due to strongly magnetic celestial bodies in their neighbourhood.—On the hydrological map of the department of Seine-et-Marne, by M. Delesse.—M. Degantière presented a note on the noise which accompanies or precedes the fall of hail.

BOOKS AND PAMPHLETS RECEIVED

COLONIAL.—Report of the Agricultural Conditions, Capabilities, and Prospects of the Neilgherry District: W. R. Robertson, M.R.A.C. (Madras).

AMERICAN.—The Mechanical Engineer; his Preparation and his Work. An Address by R. H. Thurston, A.M., C.E. (New York, Van Nostrand).—Monthly Report of the U.S. Department of Agriculture, Aug. and Sept.—Memoirs of the Boston Society of Natural History. Vol. ii. Part 4, No. 2.—Report of Mount St. Elias: W. H. Dall, W.S.C.S.—Bulletin of the Buffalo Society of Natural Sciences.

FOREIGN.—Bulletin de la Fédération des Sociétés d'Horticulture de Belgique (Liége).—Liste des Jardines, des Chaires, et des Musées Botaniques du Monde (Liége).

CONTENTS

ERRATUM.—Vol. xii. p. 559, col. 2, line 17 from bottom; for "sixty years" read "ten years."